Disinfectants and Their Use.

Fr. Roan

ESSAYS

SUBMITTED IN COMPETITION FOR PRIZES

OFFERED BY

THE DRUGGISTS CIRCULAR.

CONTAINING ALSO AN

INSTRUCTIVE PAPER UPON CHOLERA,

ITS DETECTION AND TREATMENT.

WILLIAM O. ALLISON, Publisher.

NEW YORK:
DRUGGISTS CIRCULAR PRESS.

1885.

ANNOUNCEMENT.

THIS little work, which we now offer to the pharmaceutical profession and to the general public, is a collection of papers received by the publisher in response to his offer of three cash prizes for the best three essays relative to the important subject of Disinfection and Disinfectants. The prizes offered were:

FIRST PRIZE, ...	$125 00
SECOND PRIZE, ...	75 00
THIRD PRIZE, ...	50 00

and the conditions to be observed by competitors were as follows: That the articles be scientifically correct, as free as possible from unnecessary technical terms, and give clear directions for the preparation and use of the disinfectants recommended.

All papers were written under assumed names, a sealed envelope containing the real name and address of the writer accompanying each. These envelopes were not opened until after the award of prizes had been made. The committee selected to decide upon the merits of the various papers were: Chairman, Prof. S. A. Lattimore, Rochester, New York, Chemist to N. Y. State Board of Health; Dr. Henry B. Baker, Lansing, Michigan, Secretary Michigan State Board of Health; Prof. Joseph P. Remington, Philadelphia, Pa., Professor of Pharmacy, Philadelphia College of Pharmacy.

We present this work with the confident expectation that it will meet with the hearty commendation and endorsement of the medical and pharmaceutical professions. The various essays contain much new and valuable information, and offer many formulæ and directions for the use of practical household disinfectants, together with methods of public disinfection.

The short chapter on Cholera, its Detection and Treatment, is one of a series of articles by Dr. G. G. Groff, which have been published in THE DRUGGISTS CIRCULAR.

DISINFECTANTS AND THEIR USE.

No. 1.

THERE exists so wide a difference of opinion as to the *possibility* of entire disinfection that the subject presents difficulties of more than usual character.

Some means to absolutely prevent the spread and modify the force of both contagious and infectious disease, which will not only protect the community but also the persons in immediate attendance upon the patient, must be acknowledged by every one to be the greatest boon to humanity; so great, indeed, as to be in the opinion of the writer absolutely unattainable. The means which have been proved efficient in modifying both the form of disease and its spread will be alone considered in this paper. As a starting point in a discussion within the above limits, it may not be inopportune to glance for a moment at the historical record of the terrific epidemics which at various times have raged so violently as to sweep away in a brief period whole communities of people who were living in filth and its concomitant conditions—overcrowded in walled towns and cities in which no attention was paid to water supply, sewerage, or habits of personal cleanliness.

Dr. Guy, in his excellent work on public health, tells us that in the twelfth century there were fifteen wide-spread epidemics and nineteen famines; in the thirteenth century, twenty epidemics and nineteen famines; in the early part of the fourteenth century there were eight epidemics and more famines. And these epidemics, be it remembered, were not local outbreaks, appearing only here and there, but they spread so far and wide that each and all of them were regarded as visitations of national disaster.

The Black Death, as it was called, appeared in England in 1348, claiming for its victims in London alone one hundred thousand persons, and its devastations in Europe

are estimated to have swept away twenty-five millions of persons, or a fourth part of the entire population. Other epidemics were nearly or quite as destructive to human life, and most of them are now proved to have had their origin and maintained their violence through the horrible neglect of even ordinary sanitary precautions. Such a state of things can no longer recur in civilized nations, because the slow but sure attention of physicians, the people, and the legislature is rapidly ensuring the best attainable water supply, drainage, and sanitary regulations, conserving life and modifying disease by isolation of the infected, and by providing skilful and humane treatment.

If to this could be added the discovery of some agent capable of destroying, *with absolute certainty*, the germs of disease, whether it be of animal or vegetable origin, a noxious gas, or an atom of decayed debris, such would be entitled to the name of a disinfectant, and would possess much more certainty of action and ease of application than anything under that name with which we are acquainted. Infection is defined differently by European and American writers, the former seldom discriminating between the terms *infection* and *contagion*, while with the latter the distinction is generally marked, and, in consequence, we read of some diseases which are highly infectious, and others which are simply contagious.

In a discussion like the present, however, it does not appear important to mark with much distinctness the difference which is said to exist, as it would seem that any agent capable of modifying the former would be efficacious with the latter. The great prominence which the press, both medical and secular, has given to the subject has familiarized the public mind with the object desired to be attained, as also the names and methods of using many of the more popular *so-called* disinfectants.

Much good has undoubtedly resulted, as persons generally have thus had their attention called to the importance of ventilation and cleanliness, both as to their persons, houses, and surroundings during health, and have adopted additional precautions when disease of an infectious nature has appeared in their midst. It at present appears impossible to measure relatively the value of the various disinfectants in use, or to tell with any degree of certainty

in what manner they act, as it is by no means settled how infection is produced. The germ theory at the present day seems to be very generally accepted, but exactly what is the status of the *germ*, how it orginates, and how it conveys infection, is still a problem which is exercising the minds of the leading scientists of the day. Pasteur, in his experiments by inoculation, Huxley and others on ferments, and Koch, who claims to have discovered the bacillus causing phthisis, and the cholera germ, are all ardent believers in the results of their laborious investigations, and are all learned men. Still there are not lacking other scientists who dispute their theories and distrust their discoveries. It seems by no means proved that the bacteria are the cause of diphtheria, as was so boldly claimed a few years ago; and who shall say but the results of future research may cause the adherents of the theories of the distinguished men above mentioned to confess that they have been too hasty in their deductions? *Infection being caused by the absorption of poisonous or disease producing germs*, how can this state of things be prevented or modified? seems to be the question. And it is now proposed to discuss the value of the various methods.

Preventive measures have done much to control disease irrespective of disinfectants. Better food and more healthy dwellings have given the people more resisting and recuperative force; and in that one disease smallpox, vaccination, combined with isolation, has undoubtedly reduced an almost ever present pestilence to a condition as manageable as measles. Typhus fever seldom exists at the present day as an epidemic, though in the past it was the fever of the poor at all seasons, the dread of camp and prison life in time of war, and the constant attendant on seasons of business depression, when large numbers of the wage-earners were poorly fed and clothed, and overcrowded in dwellings, owing to their inability to get remunerative employment. Disinfectants are supposed to have the power of neutralizing or destroying the disease engendering germ; and to act in this way it is necessary to have one or a number of molecules of the disease producing organism in the presence of one or a number of molecules of the disinfectant, and probably it requires several, perhaps hundreds, of the latter to one of the

former; the proportion is mere guesswork, as in the nature of things it must always be.

Heat and cold respectively, if intense enough, are the most perfect disinfectants; yet diphtheritic membrane which had been kept frozen all winter, upon being thawed and moistened in a culture medium, was found to be swarming with living bacteria, the then generally accepted cause of diphtheritic infection. Free ventilation, diluting *infected* air by the admixture of fresh, uninfected air, has probably done as much or more toward reducing the spread of disease as any other one thing, and is always beneficial to the patient as well as to the attendants. Quarantine and isolation are factors largely controlling spread of disease, and should always be enforced.

Charcoal is a powerful deodorant, and oxidizes offensive organic effluvia; it is very useful in purifying sewer gases and other filth emanations and accumulations.

Chlorine decomposes sulphuretted hydrogen and ammonium sulphide with great certainty, and is an energetic destroyer of all organic substances subject to decay. In the form of chloride of lime it is extensively used, and can be highly commended. It cannot, however, be much used in the sick room, as its fumes are very irritating both to the eyes and lungs. The principal chlorine compounds can be purchased in the shops, or it can be produced in any one of the following ways:

(1) To equal parts of common salt and binoxide of manganese add two parts of water and about the same quantity of strong sulphuric acid.

(2) To one part of powdered binoxide of manganese add four parts by weight of strong muriatic acid.

(3) To three parts of bleaching powder add one part of strong sulphuric acid.

The quantities required depend upon space to be disinfected. *Bromine* vapor can be used by exposing a solution of bromine in open dishes, and by some is held in high esteem. The fumes are very irritating, and, like chlorine, can only be used in very moderate quantities in inhabited rooms, consequently it cannot be relied upon as an aerial disinfectant.

Carbolic Acid possesses the power of destroying sepsis and preventing putrefaction in a high degree, and is de

servedly popular. It should be used in solution highly diluted in form of spray, and will also be found very useful to pour on excrement, urine, etc., in the sick room.

Copperas.—The common commercial sulphate of iron is an excellent germ destroyer, and when used in the proportion of three pounds of the salt dissolved in a gallon of boiling water, it is probably the best of its class for pouring into sinks, small sewers, privy vaults, and upon masses of objectionable matter.

Iodine diffused through a room by exposure in small quantity on hot plates is a powerful antiseptic.

Chloride of Aluminium is a powerful disinfectant, non-poisonous, inodorous, and cheap. Professor Wanklyn says that "for removing fœtor and effluvia it is better and more available than any agent with which I am acquainted. In this respect it is incomparably superior to chloride of lime. It is not volatile, consequently cannot be regarded as an aerial disinfectant." Its chief usefulness will be found in washing infected clothing, and as a scouring material for cleansing rooms, also as a sewage and filth deodorant. The impure solution of this salt is the proper form for disinfecting, and is known under the name of *chloralum.*

Potassium Permanganate is essentially an oxidizing agent, and, being odorless, is very valuable in the sick room; used by exposing a strong solution on plates, renewing as frequently as necessary.

Chloride of Zinc.—The solution of a strength of twenty-five grains to the fluid drachm of water, diluted with eight times its bulk when used, is excellent in destroying ammoniacal compounds, and is highly recommended for disinfecting clothing which can be washed, vessels, spoons, dishes, urinals, etc., in the sick room.

Sulphur Dioxide, or sulphurous acid gas, is considered by all observers the *only reliable* agent for thoroughly disinfecting a room from which a person suffering from infectious disease has been removed, also whole houses, quantities of bedding, clothing, and merchandise. The room or rooms must be vacated and closed as tightly as possible; roll sulphur is then placed in iron pans, supported on bricks, in tubs containing a little water, a little alcohol poured upon the sulphur and then ignited; the operator then withdraws, closing the door tightly. The

fumes generated will permeate every part of the rooms. The house must remain closed for twelve hours afterward. Closets should be thrown open, and blankets, clothing, bedding, etc , should be either hung on lines or thrown over chairs during fumigation. Two pounds of sulphur for a room fifteen feet square will be the proper quantity to use.

Many more compounds and agents might be named, as well as those of a proprietary nature and secret formula, but it is believed all the best have been enumerated, or, at any rate, that an intelligent selection from those given will meet all requirements. The better plan is not to use too many at a time, and indeed the physician should direct, and the choice be left to him unless he is known to be ignorant or negligent, in which case an officer of health ought to interfere, and, if necessary, enforce compliance with proper regulations. In conclusion, the writer would point out that aerial disinfection is the most difficult, while at the same time the most desirable. The use of agents to prevent the infection of the air by oxidizing infected matter, arresting putrefaction, and destroying volatile effluvia seems to be all that can be done in the matter of aerial disinfection, and should be persistently carried out.

It is as much the duty of the physician to direct disinfection as it is to prescribe for the patient. The sources of propagation of disease being in the air we breathe, the water we drink, and the food we eat, if charged with the disease germ, it is our duty, in the presence of epidemics, to use especial precautions. The water supplied, if suspected or proved by tests to be impure, should be boiled before it is drunk. kept covered, and not allowed to be used after twelve hours' standing. Every room in the house should have the windows opened once or twice a day, especially sleeping apartments. The milk supply ought to be investigated, as many epidemics of diphtheria, scarlet fever, and enteric fever, as also diarrhœa and dysentery, and some say cholera, have been clearly proved to have originated in contaminated milk, the poison finding its entry into the milk from the use of polluted water, either as an adulterant or in washing milk cans and dairy utensils.

Great care should be used in the selection of meats, fish, fruit, vegetables, avoiding all but the best and freshest.

It is a duty which the afflicted owes to the community to cheerfully submit to quarantine and other preventive orders of the authorities regarding infectious disease.

T. H. S.

L., April 23, 1885.

DISINFECTANTS AND THEIR USE.

No. 2.

THIS term is applied to such materials and methods as may be used to prevent and destroy contagion and infection. At present it is largely believed that these words express two organic somethings—one acting by immediate contact, the other the same, besides being portable. These organisms I shall designate as microbes.

The value of a disinfectant depends upon, *first*, its power to kill the organic germ; and *second*, its adaptability. In carefully looking over this field I find but very little practically available, recent experiments having largely upset our notions of the value of the articles in common use. I find oxygen and sulphur, pure air, and heat and cold about all there is left for my subject.

Oxygen is the most aggressive of all the elements, uniting with every one of the sixty-six but one, and at enmity with everything organic. In view of this fact I will touch upon some of the most useful and available disinfectants that are left for our selection, and examine their action and comparative value as furnishers of this "matter king." *Chlorine* heads the list. This is a gas more than twice the weight of air, and largely absorbable by water. It further has the property of combining loosely with some of the elements, as lime, soda, mercury, zinc, etc., from each of which it is very easily separated, and to which fact they owe their value. Before going further I will endeavor to explain its chemical action as a disinfectant. Its molecules being so easily separated from its union with other substances, and having a powerful affinity for hydrogen, the presence of the least moisture will cause it to decompose the molecules of water, seize the hydrogen atoms, and immediately form hydrochloric acid; while the oxygen atoms,

not being molecular, but in a nascent state, filled with extra energy, attack and combine themselves to the nearest organic substance present. Thus are new products formed; the organic disorganized; matter divorced from spirit; the microbe killed, and antisepsis accomplished. All successful disinfection is an *oxidation.*

I will notice the principal antiseptics* of value as above named:

Bleaching Powder (chloride of lime, hypochlorite of lime).—This chemical consists of lime exposed in close chambers till saturated with chlorine gas, which makes a very loosely combined substance This antiseptic, for open air purposes, is undoubtedly the most available one at the disposal of the city's Board of Health; it has to recommend it, *first,* its cheapness, *second*, it is easily used; and lastly, its prolonged and continuous action, which is of the utmost importance. As a destroyer of the microbe it is the most available to be found that leaves other substances uninjured. As its power is from the chlorine liberated, from its weight it will seek the lowest crevices of cellars, vaults, and sewers, being two and one-half times the specific gravity of the air. This antiseptic, in times of epidemics, can be sown through the streets of cities late in the evening, as the moisture from the falling dew is necessary to render its qualities active, thus saving the trouble of artificial watering. Putrid water has been rendered potable by precipitating the inorganic material with a little common alum, and the organic by this chloride.

Labarraque's Solution (solution of chlorinated soda).—This meritorious disinfectant has of late years been much neglected. It is pre-eminently a *household germicide.* In cases of contagious disease, a bottle of this solution should be kept in the house, from which a weak dilution should be made for the sick room, the air occasionally atomized with it; all utensils rinsed in it; linens soaked in it previous to washing; and the patient's mouth frequently washed with it to preserve the teeth, and save the reputation of the physician. In full strength the cellar can be sweetened up in the spring previous to whitewashing, sewers, drains, and obnoxious backyards

* All disinfectants are antiseptics.

rendered tolerant, and all insects banished from the conservatory. In fact, by a little experience with this agent, manifold uses will be found for it. It is not expensive.

Solution of Chloride of Zinc.—This is not as practical a preparation as the two preceding, but has to recommend it, the ease with which it can be prepared when others are not at hand, viz., common salt, two oz.; white vitriol, four oz.; water, one gallon. This makes an antiseptic for household and open-air purposes. Infectious clothing should be put into a boiling solution of this in the room where taken off, and the room well washed with it. I would further suggest that heavy flannels, blankets, carpets, and such materials be thoroughly cooked in a boiling solution of this salt, saturated with common salt to raise to the boiling point. As this is a disinfectant of prolonged action, it may be used in conditions indicated for the use of chloride of lime. This salt has been found to be a germicide of no high order.

Corrosive Sublimate (mercuric chloride).—This disinfectant belongs to the domain of surgery, and, as a microbicide, has no rival. In solutions as attenuated as one grain in from two thousand to five thousand of water, it is in general use as a dressing and lotion for wounds; bandages and surgical cottons are saturated with it; suppurating cavities are washed out with it; and it has become the chief adjuvant to the "antiseptic method." It is not available as a general disinfectant, as its force is lost too soon. Its molecule unites instantly to the least organic substance, calomel (mercurous chloride) being precipitated, precludes its further action. This exhausts the chlorine series, the most adaptable of all germicides; the best are the first two mentioned.

Sulphur.—This is another indirect and powerful disinfectant when used as sulphurous acid (sulphur dioxide), as *smelled* in the burning sulphur match. It is a potent deoxidizer, seizing upon the molecule of water uniting with its oxygen, freeing its two atoms of hydrogen, which in this nascent state attack carbonaceous and nitrogenous matter with great avidity, thus forming entirely new substances. Sulphur is especially adapted to the disinfection of ships, the holds of which are usually contaminated with putrid and nitrogenous material without sufficient

oxygen to purify by eremacausis ; also empty dwellings, prisons, and tenement houses. All structures should be stripped of everything in the clothing line, as this process is a powerfully bleaching one. To convince, hold a lighted match near to a red geranium blossom. To fumigate a structure the insides should be well wet with water, all apertures should be caulked, and an arrangement made to hold earth, bricks, or other substance upon which a fire can be kindled near the top of the room, upon which four pounds of sulphur must be burned for every two thousand feet of space. This is a powerful and adaptable germicide, but requires time ; and the apartment must be kept filled with the gas for at least six hours.

Permanganate of Potash.—This cherished disinfectant has had its reputation somewhat impaired in the past few months by test experiment. Although a chemical with oxygen atoms more loosely held and more abundant than any other, when liberated, which is usually accomplished with great energy, sometimes explosively, they seem to lose a portion of their oxidizing power. This probably arises from their being in such a dynamic condition as to unite with inorganic as well as organic matter, thus wasting a portion of their power.

Solution of Permanganate of Potash.—This solution is made by adding eighty grains of the potash to a pint of soft water. It is of a deep purple color, and, when diluted, a light blue. This mixture is a most agreeable and effective household disinfectant and deodorizer (terms not synonymous), being entirely odorless itself. This solution, diluted with two-thirds water, is invaluable in the dissecting and post-mortem rooms to clean hands, instruments, etc. As a lotion for advanced cancerous ulcers it has no equal, rendering the apartment and patient tolerable to the attendants. As an injection for suppurating cavities, it is probably superior to the mercuric chloride. I understand that rancid butter and lard have been completely restored by working them in a very attenuated dilution of this solution. In England it has gained a popular reputation as "Condy's fluid."

Permanganate of Soda—This salt is as valuable a disinfectant as its brother above mentioned, and, I learn, bears a very low price ; if this is the case, it should come in successful competition with chloride of lime.

Solution of Mercury and Manganese.—Made by adding two drachms each of corrosive sublimate and permanganate of potash to a gallon of soft water. This is the typical disinfectant for the sick room of a contagious or an infectious patient. In cases of cholera, typhoid, and consumption the dejections, secretions, and expectorations should be received in vessels partly filled with this fluid, which should be set aside for the space of an hour, then carried to a distance and emptied in a hole prepared for the purpose, and a little earth thrown thereon. In the case of death the remains should be washed in this fluid, but in no case should it be used as a bath for the patient but in cases of scarlet fever and smallpox. Condy's fluid or Labarraque's solution is adapted for that purpose. This fluid should be kept in wooden vessels and handled by trained attendants, as it is a violent poison.

Charcoal.—This is an absorbent and deodorizer directly, and a disinfectant indirectly through its affinity for organic matter when wet, and oxygen when dry ; as the latter destroys the contained organisms by a slow eremacausis, consequently all filters containing this substance should be left inactive half of the time to permit the air to circulate through their meshes. Charcoal filters connected with cisterns should be conspicuously constructed with a view to switching the supply pipe away from them. This last one seems to exhaust the list of practicable disinfectants, most of which, especially the household ones, can be extemporaneously prepared by the average housekeeper, and all of which can be obtained at any drug store, and each of which, with a little experience, will show its use, qualities, and adaptation.

Before drawing to a close it seems proper to expose in this connection some popular delusions, viz.: That common copperas is of great value ; that the smoke of burning tar or sulphur in an inhabited apartment is very effective, when it has long since been demonstrated that pure air and efficient ventilation are the only adaptable disinfectants in this case. In surgical therapeutics such chemicals as carbolic acid, creasote, iodoform, the sulphates, borates, and salicylates have found their level as germicides of a low order, salicylic acid only holding its reputation as an enemy to the zymocytes of the cider barrel.

In constructing this thesis I have sought to make it as plain and practical to the average reader as possible, and as attractive to the scientific as the few technicalities introduced may admit.

"AGRICOLA."

DISINFECTANTS AND THEIR USE.

No. 3.

THE term disinfectant, in its more circumscribed meaning, implies the property possessed by certain substances of destroying disease germs, and of purifying and deodorizing infected atmosphere.

The importance of a subject which deals so forcibly with the very cause and sequence of the death-dealing contagious diseases which have, from time immemorial, decimated the races of all countries, cannot be overestimated. The history of epidemics reflects, to our astonished understanding, the dreadful mortality from preventable diseases—diseases which, for the observance of certain hygienic rules, among which disinfection plays a part of no mean importance, might have been obviated, or at least successfully combated, and eventually, perhaps, even extirpated. The three beautiful graces of hygiene, namely, cleanliness, disinfection, and a proper regime, go hand in hand, the messengers of life, health, and happiness. Their laws are immutable, their mandates imperious, and they should not be received and handled with indifference. Yet, strange to say, such is undoubtedly the case, even among classes whose pecuniary means facilitate the following of a course so conducive to the welfare of themselves and their fellow beings; these will be found in their daily meanderings surrounded by cesspools, swill-barrels, garbage, ill-constructed sewerage, etc. The cistern or well is only too often found in juxtaposition to the privy vault, the stable within reach of the kitchen. The alleys and waste-water conduits, the outhouses and yards, which should always be kept scrupulously clean, will be seen reeking in filth and stench. The accumulated dirt of years will moulder and decay in unoccupied rooms of even pretentious dwellings. And why this eminently criminal negligence? Simply because the minds of

the people have not been properly educated to an appreciation of the inestimable importance of the subject. Simply because the authorities, both State and municipal, fail to attach to their sanitary enactments that impressiveness which carries with it conviction and reverence. These weak and defective laws often lie inoperative for years, until some threatening scourge again exhumes their moss-covered deformity. This is a palpable imposition and a grievous wrong ; *the strict enforcement of proper sanitary laws and regulations should never be limited to the prevalence of an epidemic.* They should be continually and without intermission in full and faithful observance. in the healthiest as well as the most insalubrious localities Their observance should be considered as essential to existence as the food and water demanded by the starving wretch. Until this fact is firmly impressed upon the popular mind, and not until then, can we hope for immunity from the occasional onslaughts of pestilence and death.

But I must digress no further, since my design is to devote myself especially to disinfectants, and not to the probable results of disinfection, which may be treated more elaborately in a future paper. There are many substances used for disinfection ; many, by reason of their proved worthlessness, and still others by the ridiculous theories advanced in favor of their efficacy, have been discarded ; but I will dwell upon only those conceded to be of real value either as deodorizers or bacillicides, and propose, for the purpose of methodizing the contents of this paper, to classify them as follows :

First, or general, to comprise those used for exterior disinfection in sewers, sinks. vaults unoccupied rooms, cellars, etc.

Second, or special, including those suitable on account of their non-poisonous qualities for dwellings, hospital wards, and indoor use generally.

Third, or therapeutic, such remedial agents as are known to possess antiseptic properties, and are beneficial in the prevention and cure of disease.

The method of operation of all disinfecting agents is exerted either through chemical action, by mechanical force, or by an exercise of both these characteristics simultaneously. The latter are not only the most numerous,

but also the most important and reliable, and when a substance is found which is capable of exhibiting in a sufficiently marked degree the dual capacity of germ extinguisher and purifier, in short, a mechanico-chemical disinfectant, it may be relied upon with confidence and satisfaction.

When a disinfectant acts by chemical influence alone, molecular changes take place in both the infected matter and the disinfecting principle, resulting in the ultimate decomposition of the previous molecular structure of both. This becomes apparent in the action on miasmatic gases and pernicious exhalations of all kinds, in which complete interchange of elements invariably results in the obliteration of the objectionable matter.

A mechanical disinfectant acts specifically through its property of destroying the microscopic vibriones known to accompany all contagious diseases, and which are presumed, on good grounds, to form the basis of the dissemination and virulence of epidemics. While these cannot but be of great economical importance, since, in destroying the germ, all future propagation is certainly ended, yet they must, of necessity, be far superior to those which exercise complete metamorphic sway over the low form of vitality and the media in which it flourishes. A mechanical disinfectant, while it may be antiseptic, and, to a certain extent, prevent or interfere with the process of putrefaction, has not the power to neutralize the noxious and fœtid vapors previously present

First, and foremost, of the popular disinfectants is lime (calcium protoxide, CaO). The importance it maintains in the front rank of disinfectants has been justly won by the repeated trials to which it has been satisfactorily subjected for many years. Its destructive influence over all forms of animalcular life is well known. And being itself inodorous, it combines, to a high degree, the characteristics of a genuine disinfectant. Its operation is simple, and as interesting as it is instructive. When brought in contact with organic matter in a putrescent state, it absorbs a molecule of water, and is converted, with the evolution of great heat, into a hydrate. The elevated temperature, together with its strong escharotic properties, are more than sufficient to destroy the bacilli and

fungi which may be present. Disintegration sets in, carbonic acid, sulphuretted hydrogen, and carbon are evolved; these unite with the hydrate of lime, which, when the reaction is complete, falls to an inert powder, the larger part of which consists of carbonate of lime, while the adjacent earth and surrounding atmosphere are left untainted and healthful

A combination of lime with chlorine, perhaps the best of all the bacillicides, is very generally employed, and the supervening action, while differing materially in detail from the preceding, leads ultimately to identical results. The chlorine, which is but loosely combined with the lime, being a superchlorinated salt, is gradually liberated, exerting its toxic property on the living organisms. Its affinity for hydrogen facilitates the formation of hydrochloric acid. The lime is transformed slowly, as detailed above, with the exception that, containing a large proportion of chloride of calcium, it becomes at first hygroscopic, and, finally, by subsequent oxidation, reverts to the form in which it constitutes the largest part of the earth's composition

Crude carbolic acid, another of the popular disinfectants, is not so satisfactory in its results, and the presence of its acrid fumes does not by any means vouchsafe absolute security from the dangers of germ poison. Though it has been proved a disinfectant, and is considered by some authorities as *par excellence*, the *forte* of carbolic acid lies more in its antiseptic properties as a prophylactic than otherwise. While it, beyond all shadow of doubt, entertains, to an eminent degree, the power of destroying the lower forms of animal life, as do all mineral poisons and escharotics, it, nevertheless, is entirely void of the vital *desideratum* of absorbing or rendering inert the noxious effluvia which permeate the atmosphere of an infected locality. That there is a diminution or apparent absence of stench during its use is explained by the fact that, being volatile and of strong natural odor, it commingles, mechanically, with the offensive vapors, and, being in excess, disguises, for a time, the fœtor known to be present. This fact can be conclusively proved by a very simple experiment: Take, for instance, a privy vault, nearly filled, and in an unusual state of fœtor and corruption. Let it be thoroughly impregnated with crude

carbolic acid. Allow the vault to be closed except to ventilation, and it will be noticed that, with the dissipation of the acid, the stench will return, while the corrupted condition of the contained matter will remain virtually unchanged. This same experiment may be made with either dry chlorinated or burnt lime, and the result will be found beyond comparison. After the lapse of a short period the contents of the vault will have undergone a species of exsiccation and cremation. Complete molecular disarrangement will have taken place; and, though there will be present large quantities of unaltered organic matter, it will be in a remarkable state of anti-putrefactive preservation, and comparatively inodorous. Thus I draw the parallels of comparison between these two great disinfectants, feeling confident in the assertion that every careful experimentalist and thoughtful observer will bear with me in the statement made.

Another of the important disinfectants for general use is sulphate of iron, commonly called copperas. This salt is worthy a much higher place as a disinfectant than is usually accorded to it. In point of efficacy it is second only to lime or its chlorinated compound, and in many instances, where the odor of the latter becomes objectionable, is even preferable to it. Its action, though slower, and differing in result, is in theory the same. A double decomposition and interchange of elements takes place between the disinfectant and the infected matter to which it has been applied in the form of a concentrated solution. Sulphurous acid is slowly liberated, acting with similar potency to chlorine as a germicide. This being further decomposed, the sulphur is precipitated, while the free oxygen, together with carbonic acid pre-existing, are absorbed with avidity by the protosalt of iron, which finally, having spent its vigor as deodorizer, disinfectant, and antiseptic becomes sesquicarbonate of iron

The use of nitrous acid fumes as a disinfectant in hospital wards, etc., originated with Dr. Smyth in England, and, when properly and cautiously used, is doubtless a most powerful disorganizer and purifier of vitiated atmosphere. The gas is extremely poisonous, rapidly asphyxiating those inhaling its corrosive fumes Not unlike chlorine, bromine, iodine, etc., nitrous acid decomposes sulphur-

etted, phosphoretted, and carburetted hydrogen, all or some of which constitute the nubecula of effluvia arising from decayed animal and vegetable refuse.

With this I will leave the general disinfectants, though there are many more which have been used from time to time. Fumigations of coal and pine tar and the resins and woods of various coniferous and other trees were, up to a recent date, much in vogue—their claims to success as disinfectants being entirely due to the cresylic and kreasotic compounds evolved during their use. Burning sulphur is still frequently employed; and while the foregoing have been pretty generally superseded by more or less complex technical compounds, simple fumigations of sulphur are held in favor, and often prove of great service.

The eucalyptus tree (Eucalyptus globulus) also deserves mention, since it may be considered the most powerful of all the natural disinfectants. The avidity with which this growth absorbs the poisonous gases of miasmatic localities is truly wonderful; as also its marvellous facility in decomposing excessively large quantities of carbonic acid —retaining the carbon, and giving off the life-sustaining, health-promoting oxygen. There are many low, swampy, disease-stricken sections which may be rendered pure and healthful by the presence of a luxurious growth of these truly magnificent trees. They should be cultivated in all localities where climatic influences are favorable, and cherished as the scavengers of the atmosphere and the adversaries of disease.

Proceeding now to the second class, or special disinfectants, which furnish a list even longer than the foregoing, I shall make it a point to dwell upon only those of recognized superiority, and to omit all such as the experience of the past may have with reason discarded.

Solution of chlorinated soda, commonly called Labarraque's Disinfecting Liquid, is of world-wide repute, and, when not impaired by exposure, is one of the most reliable deodorizers, disinfectants, and antiseptic liquids in use. It can be used freely and with perfect safety in the chamber occupied by the sick; and as a prophylactic to those nursing the victims of contagious diseases, when applied by bathing the hands and body freely with an attenuated solution, is beyond all question the safest, surest, and cheap-

est thus far introduced to the notice of the scientific world. In the treatment of malignant diseases, such as typhus fever, scarlatina, small pox, diphtheria, etc., the solution of chlorinated soda should be liberally resorted to. The room and bed clothes should be daily sprinkled with it; the body should be washed and the mouth rinsed with water containing from two to five *per cent.* of it. The vessels for the reception of fæcal excrement, urine, and sputa should be cleansed with and contain it at all times. Porous cloths moistened with it should be hung up in different parts of the room. If these precautions are faithfully observed, not only the virulence of the disease will be mitigated in the patient, but those exposed thereto will be comparatively safe from its influence.

A solution somewhat similar to the foregoing in which the base is replaced by zinc and the chlorine is not beyond saturation, and consequently is without smell, constitutes what is known as Sir William Burnett's Disinfecting Liquid, introduced in 1840. It consists of 20) grains of chloride of zinc to each imperial ounce of solvent; and acts as a powerful deodorizing and disinfecting agent. Its antiseptic properties are equal, if not superior, to Labarraque's solution. Its operation in arresting the putrefaction of animal matter is prompt and decisive. When ingested into the blood vessels, it preserves bodies for future dissection without impairing the texture of the muscular and membranous portions. For the purpose of embalming the bodies and preserving the features of the dead in a life-like condition for indefinite periods, it stands without an equal. It has been extensively employed for the disinfection of ships, hospitals, dissecting rooms, water closets, privies, and even sick rooms. The universal objection to its general adoption, however, is its poisonous nature; this, of course, renders it unsafe for use in and about inhabited premises

A solution of the chloride and bromide of aluminium, commonly called "Bromo-Chloralum," has been of late years extensively used in this country; and, as it is perfectly inodorous and non-poisonous, and evidences to a pre-eminent degree the germicide, disinfecting, deodorizing, and preservative properties of the three elementary substances entering into its composition, there is little room to question why it should not be the most desirable

preparation of the kind in the market. Whenever the odor of chlorine, which is constantly perceptible in the chlorinated soda, is objectionable, the use of bromo-chloralum should always be recommended as a satisfactory substitute. Its action in arresting organic decomposition, in purifying infected atmosphere, and in deodorizing putrid exhalations and excretions, is identical with it, and in every particular quite as prompt and efficient.

Pure carbolic acid, diluted with water, is extensively used for interior disinfection, and the same objections advanced with reference to the crude preparation, together with its strong, and, to some weak and delicate patients, insufferably disagreeable odor, and poisonous influence when its use is protracted, bring to bear a strong incentive in opposition to its general adoption. Its germicide properties remain undisputed, but it is practically inert as a deodorizer or purifier of polluted atmosphere. Its effect is merely to disguise the fœtor by an excess of its own penetrating odor.

The use of a blast of air heated to between 212° and 240° Fahr. for the disinfection of infected clothing has been frequently resorted to, and is obviously *par excellence* in its results. The application, however, in the absence of necessary apparatus, is entailed with difficulties not easily overcome. It thus remains impracticable, and receives but little encouragement by way of adaptation to general usage.

Therapeutic disinfectants.—This third and last subdivision of my subject, being rather foreign to the purpose of this article, will not receive that particular attention which its great importance merits.

Several years ago, anterior to the discovery of the bacilli and the germ theory of disease, many of the numerous maladies now so successfully treated by antiseptic medication were considered incurable. The virtues of salicylic and boric acids and their salts of iodoform, thymol, resorcin, napthalin, etc., were unknown to the medical profession ; and the action of carbolic acid, creasote, and other products of tar, charcoal, nitre, cinchona and its alkaloids, were, at best, imperfectly understood. But the microscope dispelled all shadows of doubt, and what seemed impenetrable darkness in the depths of learning is now

illuminated by the brilliant rays of successful scientific research. The incredible advances made in the treatment of all septic diseases, transmittable and non transmittable, is truly marvellous; and I venture to say the time is not far distant when the treatment and cure of phthisis, septicæmia, cancer, necrosis, and all diseases involving organic decay, will be considered by the skilful physician as commonplace infirmities, and treated successfully with this truly wonderful method of therapeutic disinfection. In conclusion, I cannot refrain indulgence in the prophecy that, while the discoveries of Koch seemingly extend to the very interior limits of animalcular existence, the extent of possibilities concerning living organisms, within the living and dead bodies of either animal or vegetable, are in truth as far beyond our comprehension as were the satellites of Jupiter before the invention of the telescope. The field for occult research grows broader as we penetrate its deep recesses; and since our knowledge of animalcules, prior to the discovery of the microscope, was devoid of their interesting forms, what may not become apparent in the sphere of invisible life after the discovery and construction of an instrument of such vast and unprecedented magnifying power, which will disclose to view, not only the mere existence, the method of propagation and multiplication by germination, and the motion of their vermicular forms in the element of their growth, but also the intricate minutiæ of their organic structure and processes?

R. H. B.

San Antonio, April 16, 1885.

DISINFECTANTS AND THEIR USE.

No. 4.

Disinfectants have been defined as agents "capable of destroying the infective power of infectious material." And in a wider sense they are agents "which oxidize or render innocuous decomposing organic matter and offensive gases, which arrest decomposition, or which prevent the spread of infectious diseases by destroying their specific contagia." In popular belief, a disinfectant is any agent which conceals one bad odor by means of another.

"The prime conditions of health in a house depend upon *cleanliness*, *pure air*, and *unpolluted water;* the prompt removal of all refuse; and the perfect exclusion of all matters arising outside of the house." Zealous and *constant* attention must be paid to cellars, pantries, passages, yards, outbuildings, privies, so as to prevent the accumulation of filth, garbage, or masses of decomposing organic matter, which are so prejudicial to health. Mould, dampness, and foul smells are never to be neglected, even for a few hours. A bad smell is nature's warning of danger. Eternal vigilance in these matters is the price of health in the family.

The people need to be taught that "prevention is better than cure, and far cheaper;" that it is much better to so live that disinfectants will not be needed, than to be careless of refuse matter, of pure water, of ventilation, of cleanliness of house, of yard, and of person, and then strive by means of chemicals to purify great masses of filth in the home and its surroundings; for there is a strong popular brief that the commercial disinfectants, especially if possessed of powerful odors, are capable of purifying all manner of filth and nastiness. To offset which, there is good reason to believe that one-half, at least, of the disinfectants on the market have no value, and the other half are so used that they are almost valueless.

In this article, only those substances of known *reliability*, *safety* for *general use*, and of a price to place them within the reach of all will be considered. The aim will be to benefit all who are willing to employ plain sanitary knowledge.

RELIABLE AND SAFE DISINFECTANTS.

1. Sunshine and oxygen.
2. Whitewash.
3. Dry heat, boiling water, and superheated steam (for clothing, furniture, utensils, etc.).
4. Fumes of burning sulphur (for houses, ships, etc.). The powdered sulphur is placed in an iron vessel, some alcohol added, and the mass ignited. The quantity necessary is 3 lb. for every 1,000 cubic feet of space. Rooms, etc., must be tightly closed for twenty-four hours after sulphur has been burned in them. The gas produced is a dangerous poison.
5. Sulphate of iron (green vitriol, copperas). Dissolve 3 lb. in a pail of water. (For drains, privies, etc.)
6. Dry earth, powdered charcoal, slaked lime, ground gypsum (for accumulations of refuse matter). Coal dust and sifted coal ashes have little value here.
7. For clothing that can be washed:

Zinc sulphate	4 oz.
Common salt	2 oz.

Dissolve in one gallon of boiling water.

8. For water, thorough boiling.

PRACTICAL DISINFECTION.

1. *Sunshine and free ventilation.*—Sunshine and oxygen are nature's disinfectants. Could they freely and constantly enter our habitations, except where men are aggregated in great numbers, no other disinfectant would be needed. They have no equals, and no substitutes are known to science. It is well said of the habitation where sunshine cannot enter, the doctor will; sunlight and fresh air should flood every nook and corner of the house and of the surrounding premises. Trees, curtains, blinds, ivy, whatever stands in the way, should be removed. When a house, or a single room, is disinfected, too much stress

cannot be laid upon the subsequent long-continued and thorough exposure to air and sunshine.

2. *Whitewash* is a most valuable and cheap disinfectant. It should be liberally used in cellars, basement rooms, water-closets, and wherever there is dampness or mustiness of walls. Not once a year, but once a month, and better still, once a week during the warm months. Whitewash should also be applied to the walls of rooms in which has been an infectious disease; for this last purpose there is no substitute.

3. *For drains, cesspools, urinals, etc.*—A solution of copperas (iron sulphate), 3 to 5 lb. to a pail of water, should be used, in sufficient quantities and frequently. The quantity should be sufficient to flush the pipes, and in hot weather each alternate day will not be too often. A teacupful of this solution should be placed in bed-pans, chambers, etc., after use; a quart to a gallon a day in urinals, privies, etc., according to number using. A large, foul privy, say 6 feet in diameter by 12 feet deep, will require not less than 25 lb. of copperas to disinfect it. The rule here should be to use the disinfectant *until every foul odor disappears.*

4. *Heaps of refuse, sodden land surfaces, etc.*—These should not be permitted to occur, but when they are discovered, it is better to cover deeply 3 to 6 inches, with pulverized charcoal, earth, ground gypsum, or air-slaked lime. After a day or so, the mass may be removed, best at night, and the earth covered again with the above substances to the same depth.

5. *Disinfection of bedding, clothing, etc.*—(A.) *Articles which can be washed.* These should be placed in boiling-water which contains in each gallon 4 oz. of zinc sulphate and 2 oz. of common salt. It is very important that they remain in this water an hour or more, and that the boiling water penetrates to every interior part, which it will not do unless the goods are opened up and spread out with care.

(B.) *Articles which cannot be washed.* These are furs, woolen goods, beds and bedding, stuffed furniture, etc. These can only be thoroughly disinfected by exposure in closed rooms to superheated steam or to hot air (250° to 300° F.). Every town should have a public oven or arrange-

ment where disinfection by hot air or superheated steam could be carried on under official inspection. Where this cannot be done, the articles should be spread out as much as possible on lines in a closed room, and exposed to the fumes of burning sulphur.

6. *Disinfection of a house or room in which a contagious disease has existed.*—Thorough disinfection demands that the house or the room be vacated by its occupants. "Spread out and hang upon lines all articles of clothing and bedding; open all closet doors and bureau drawers; well close the fireplace, windows, and all openings, then take brimstone (sulphur) broken into small pieces, 3 lb. for every 1,000 cubic feet, put into an iron dish supported over water, pour on some alcohol, and set fire to it. Close the door and all crevices, and allow the room to remain shut up 24 hours. The rooms should then be thoroughly ventilated, by opening doors and windows. The ceiling should be whitewashed, the paper stripped from the walls, and burnt, and the furniture and all wood and painted work be washed in boiling water containing zinc sulphate and common salt. The floor should be thoroughly scrubbed with the same solution. Boil everything which will admit of it. Beds, mattresses, and articles which cannot be washed should, if possible, be submitted to the action of heat or steam in a disinfecting chamber. Finally, the room should be open to air and sunshine as long as possible before it is occupied. *Without such thorough disinfection the room cannot again be safely occupied.*

7. *The sick room.*—There should be as few curtains, hangings, carpets, and woolen articles in the sick room as is consistent with comfort. It should be thoroughly ventilated and open to sunlight generally, and kept entirely free from odor, and never *close*. The linen, clothing, bedding, utensils, dishes, and every object touched by or in contact with the patient, should be isolated, and such as will permit should be thrown into boiling water, and there remain at least half an hour. Food and drink should be touched by no one except the patient. The chamber vessel should constantly contain a solution of copperas of double strength, and the dejecta should be buried; sputa and discharge from the nostrils should be received on pieces of rags, and burned. In diseases as scarlet fever and

diphtheria, where the contagia reside in the skin, the body may be anointed with oil. The nurse should be restricted to the sick room, or otherwise isolated.

8. *Drinking water.*—Ordinary filtration will not answer at all. Suspicious water should be boiled. Dr. Parker recommends boiling with exhausted tea leaves for the astringent effect. Potassium permanganate may be added to the boiled water until it produces a faint pink tint, which should be permanent. But boiling suspicious drinking water must be the main reliance. Where people persist in using suspicious well water, the authorities may prevent this by throwing into the well a large amount of extract of logwood or other chemical substance to strongly discolor the water.

9. *The homes of the poor.*—The greatest need of disinfectants is generally in the homes of the poor, who are least able to use them in an intelligent manner. Hence discreet persons should be appointed as examiners by health boards, who, without exciting alarm, or arousing the prejudices of this class of the population may detect unsanitary conditions, and in a scientific manner apply the remedies.

10. *Disinfection of the dead body.*—In diseases of a contagious nature, after the death of the patient, the body should be wrapped in a sheet and saturated with a solution of copperas or of zinc sulphate, placed in the coffin, and the lid screwed down. Burial should be private, and occur as soon as possible.

Carbolic acid and "chloride of lime," as well as some other well-known disinfectants, have not been mentioned, from the fact that commercial articles are of uncertain purity and strength, and also because by their odors they are liable to cover up the noxious odors of organic decomposition, and because people at large believe so long as carbolic acid or chloride of lime can be smelled, there is no need of further care. A bad smell is nature's warning of danger, and should never be covered up, but removed root and branch.

PARACELSUS.

DISINFECTANTS AND THEIR USE.

No. 5.

WHEN we reflect upon the ravages of cholera lately prevailing in Europe, and as the past history of such epidemics has taught us to expect the disease in America about two years after having occurred in European countries, also the frequent occurrence in our own country of diseases —parasitic in origin—that annually carry away many valuable lives, the importance of this subject impresses itself upon every thinking mind. It becomes, therefore, of prime importance that the masses be instructed, that we may all work in unison against the invasion of a common foe.

Disinfectants are agents employed for the purpose of destroying two kinds of poisons which give rise to disease: first, those that are generated in the body, called contagions; second, those generated out of the body, called miasmata. The contagions have power to develop in the body, that is, the power of self-propagation when taken into the system. Miasmata do not possess that property, but are always matured without. Although in all instances the contagions cannot be demonstrated, yet there is strong presumptive evidence that they are living organisms of very low order, which, when introduced into the system in sufficient quantities, give rise to morbid effects peculiar to their kind, and are to be destroyed by substances poisonous to such low forms of life.

The widespread and popular error that bad odors and foul-looking places are sources of disease should be corrected; for disease germs are by no means necessarily connected with such. The most deadly forms may completely saturate the air of an apparently clean chamber, and the worst stinking cesspool be entirely free from them. Yet, as decomposition may foster the growth and bad gases act

as carriers of disease germs, cleanliness is to be emphatically insisted upon. The lower the forms of life, the more tenacious they are of life.

The inquiring mind will naturally ask, What must I disinfect? Where must I disinfect? and *With* what must I disinfect, in order to prevent the increase and spread of these poisonous germs? Let us follow up these questions. First, until we have a patient sick of some one of the germ diseases, we can do nothing save destroy all filth and keep as clean as possible; but when we have the disease present we have a patient, and when we have a patient we must have a room in which to put him. Having brought the subject down to patient and room, we will first describe the best mode of disinfecting the room and its furniture, and then the most important matter of disinfecting all discharges and exhalations coming from the patient. Here we have the disease germs at an advantage, and beyond a doubt can succeed in destroying them; but from neglect, ignorance, or carelessness we cannot, and do not, always succeed in confining these germs to so restricted a locality; but they find their way into the sewers, thence into the rivers, and often into the very drinking water itself, even though it be from a well. The discharges from the patient being imperfectly disinfected—or no disinfection being done at all, as often happens—are thrown upon the ground near the well, and the rain percolating through the soil, carries with it the germs from the excreta, and sometimes they will be literally washed in directly by surface water. Hence it will be necessary also to speak of the disinfection of sewers and other places becoming contaminated.

The time above all others for disinfection is not after the germs are dispersed into the air, and are out of reach, but immediately on being passed from the body of the patient, and when still contained in the solids and fluids excreted. This point cannot be too strongly urged. Here they are in our power, and should be destroyed then and there; and first of all, special care must be exercised to select a disinfectant that is positively known to be capable of destroying disease germs, or else it is evident that all our efforts are vain. Select one that has been demonstrated by good observers to be reliable.

The only way the power of a given disinfectant can be

determined is to subject to its action material known to contain certain disease germs and then by inoculating some animal with the material thus treated. If the germs still be active, and reproduce the disease, then it cannot be relied upon; if not, it is reasonable to suppose it has destroyed them, and can be trusted to do it again. This is but the outline of the only way of testing the matter; in reality the experiments are much more elaborate, and must be done with the greatest care and nicety.

Beware of using patent articles so largely advertised for this purpose. The matter is too important a one to risk anything, save that which is known to be efficacious.

Supposing now that we have a room filled with furniture where a patient has died who had been afflicted with cholera; let us turn our attention to the proper cleansing of this apartment. It cannot be done with any human being in it, so it first must be vacated by all occupants.

At the requisition of the Prefect of Police of Paris, Messieurs Pasteur and Roux performed experiments, the results of which were made known to the Academy of Medicine, with the view of ascertaining what gas would be best for disinfecting rooms which had been occupied by patients who had suffered with contagious diseases. These gentlemen, after careful investigation, concluded that sulphurous acid gas is the most efficacious; for the production of which they recommended the burning of bisulphide of carbon, on the score of cost and non-injuriousness to metals and furniture. They experimented with the gas as obtained from three sources, and found that each one had its own advantages and disadvantages. The first was the simple burning of flowers of sulphur; second, the liquefied sulphurous acid; and third, the burning of the bisulphide of carbon. The rooms selected for the purpose were closed for twenty-four hours, after receiving tubes containing different disease germs, and specially the comma bacillus—the germ, according to Koch, concerned in the production of cholera—and tubes of vaccine lymph. After each experiment the tubes were taken to Mr Pasteur's laboratory to be compared with others that had not been subjected to the action of the gas. The results arrived at by these investigations are worthy our deepest consideration, in view of the fact that it is quite possible that we may be visited by cholera at no very distant day.

The means employed to produce the acid made it possible to burn as much as 18 or 20 grs. of sulphur to the cubic foot of space, much more than necessary to render the material containing the different germs completely inert; 8 grs. to the cubic foot of space rendered all inert save that of charbon. The process of making the acid by simple combustion of flowers of sulphur was found to be the simplest and cheapest of the three methods. To produce the gas in this way, a piece of sheet iron is placed in the centre of the room, and several bricks joined with sand laid neatly upon it ; or for greater safety the bricks may be placed in a tub containing water. The sulphur should then be thoroughly moistened with alcohol or turpentine, preferably the former. Close the room tightly, and, after lighting the sulphur, step out immediately, and close the door. Do not burn less of the sulphur than 8 grs. to the cubic foot of space to be disinfected. The disadvantages of this method are: more or less danger of fire, and injuriousness to metallic objects in the room, especially iron and copper, a metallic sulphide being formed upon them. Keep the room closed for twenty-four hours.

The second method recommended by these gentlemen was to use the liquefied sulphurous acid gas, which does not involve the same inconvenience as the burning of the sulphur, but is considerably more costly, being sold by the siphon at one dollar, and contains one pound and a half; and to be effective one siphon must be used to every 706 cubic feet. To use the siphon it is directed that a rubber tube be connected with a vessel in the apartment to be disinfected, and then passed through a hole in the floor, or through the wall; after closing the room tightly, insert the nozzle of the siphon in the end of the tube; pressing upon the lever then liberates the gas, which, flowing through the tube, reaches the vessel in the room, where it rapidly evaporates. It is exceedingly penetrating, and does not in the least affect metallic objects. It is needless to say that these siphons are not for sale in the smaller towns.

The third method of producing the gas, which was specially recommended by Messieurs Pasteur and Roux, is the burning of carbon sulphide, in that it is cheap, practical, and can, with the proper apparatus, be furnished

continuously, regularly, and slowly. Burning carbon sulphide has hitherto been attended with danger, but this has been overcome by the invention of a new burner by Ckiandi Bey, the cost of which is about ten dollars. It is to be recommended that ships be furnished with an apparatus of this kind, as, in case of any contagious disease making its appearance, a handy and reliable means of producing the gas is at hand. The carbon sulphide is sold at about five cents a pound, and five and a half pounds will be sufficient to disinfect a room of 3,500 cubic feet capacity. After having filled the room with the requisite amount of gas and allowed it to remain for twenty-four hours, it is then ready to be cleansed of dust and dirt; and, as an extra precaution, the woodwork and all dust catching surfaces should be washed with a solution composed of two drachms of the bichloride of mercury—corrosive sublimate—to one gallon of soft water.

During the continuance of the disease careful attention should be given to the thorough disinfection of the discharges from the patient, for in each one there exists a hot bed of disease They should be attended to at once

One of the very best disinfectants for the excreta of patients, as shown by a recent report of the Committee on Disinfectants of the American Public Health Association, is the chloride of lime, which can be purchased at five cents per pound by the quantity. It should be dissolved in soft water, in the proportion of at least four or five ounces to the gallon, and for each discharge of a cholera or typhoid fever patient, one pint of the solution should be used, allowing them to stand mixed some minutes before finally emptying. The matter vomited, if any, should receive the same treatment; in fact, all discharges of whatever nature. Allow the patient to expectorate into a vessel containing the solution.

Another powerful disinfectant, and one which can be relied upon, is the bichloride of mercury, which is as effective as the lime, but slower in its action; hence, if it be used, allow the discharges after receiving the solution to stand one hour. It should be used in the strength of three drachms to the gallon of soft water, and it should be remembered that it is highly poisonous and destructive to lead pipes. The cost is about the same as the lime, but it

is odorless, while the chlorine liberated by the chloride of lime may be objectionable to the patient. The Committee on Disinfectants of the American Public Health Association recommended a solution made by dissolving bichloride of mercury and permanganate of potash, each two drachms to one gallon of soft water, to be used for the same purpose as the chloride of lime.

Another disinfectant which can be relied on is the liquor sodæ chlorinatæ, or Labarraque's solution. It should be mixed with five parts of soft water, to be used in the same quantity as the chloride of lime. It will cost about nine cents a gallon ready for use. Diluted with 20 or 25 parts of water, it may be used to sponge the body of the patient. It is of the greatest importance that all wearing apparel, bed clothing, contaminated towels and handkerchiefs should be thoroughly disinfected before leaving the room. It can be done quickly, certainly, and easily by immersing in boiling water. Such as cannot be boiled may be subjected to dry heat, which must be as high as 230° Fahr., at least. Such articles as cannot be disinfected should be burned. Where heat cannot be used on the clothing, the committee above referred to recommended the following: To one gallon of water add four ounces bichloride of mercury and one drachm of permanganate of potash to color. To use this strong solution add one ounce of it to one gallon of water, and immerse the clothing in it and allow to remain for two hours; after this, wring out and send to wash. Do not use a metal receptacle, as it will precipitate the mercury. Use earthen ware; a large mouthed open jar will answer.

If a privy vault or cesspool has been known to be contaminated, it should be at once disinfected, and for this purpose the chloride of lime may be used.

First, wash all contaminated spots, and to every thirty pounds of excreta—estimated—use one pound of the lime in solution as above directed, and each day thereafter, during an epidemic, sprinkle the lime in powder over the surface. If the odor from the lime be objectionable, use one ounce of the bichloride of mercury to every thirty pounds of material.

Where any suspicion of the drinking water exists (when an epidemic is prevailing, it should be done any way), the

water should be thoroughly boiled and filtered. It may be cooled with ice. The common filter paper used by the druggists will answer where the quantity is small.

Where it becomes necessary to disinfect a sewer, some one of the above agents may be used. If crude carbolic acid be selected, as is often done, do not use it in a less concentrated form than one part in a hundred of water; if diluted more than this, it cannot be relied upon.

So far we have not spoken of an item of the greatest importance, that is, free ventilation. Atmosphere known to be swarming with disease germs soon loses its infecting power by free dilution with fresh air; the germs become so widely dispersed as to be harmless. Ventilate the apartments of the sick freely, and at the outset remove from the room *all* unnecessary furniture; if possible, take up the carpet; it will be easier afterward to cleanse the room.

In the foregoing, we have been careful to mention but few of the disinfectants to be found in the long list of drugs and chemicals, for the reason that most of them are too inert for our purpose; others are too expensive to be used; and others still are dangerous to handle. We have deemed it best to mention only such as have been proved to be entirely reliable, and being few in number, can be easily remembered. Much can be done oftentimes by destroying bad odors to promote our own comfort, and that of the patient also. For this purpose, some one of the many deodorizers may be selected, but do not rely upon them to disinfect, for they are entirely useless for such a purpose.

L. J. S.

DISINFECTANTS AND THEIR USE.

No. 6.

SUGGESTIONS IN REGARD TO THEIR EMPLOYMENT WITH SPECIAL REFERENCE TO CHOLERA.

THE mission of sanitary science is the development of protective measures for the benefit of health. The employment of disinfectants is the "protective measure" recommended by sanitarians for the prevention of the so-called germ diseases. A "germ" disease is considered to be one that is caused by living germs that are capable of self-multiplication in suitable nidus or environment, and of being transported to distant localities without losing their vital activity and consequent infecting power.[1] These diseases, of which the cholera is a prominent example, are also known as *zymotic* and *filth* diseases. The prevention of the epidemic extension of such diseases by the proper use of suitable disinfectants is the subject to which this paper is devoted.

Disinfection is defined to be the destruction of the poisons of infectious and contagious diseases.[2] A substance having the properties of a perfect disinfectant is probably not in existence, for the same qualities required to destroy the power of a living germ would necessarily endanger human life. Fire, certain forms of combustion, or oxidation alone are capable of completely disinfecting a locality. Disinfectants are of two kinds, natural and artificial.

NATURAL DISINFECTANTS.

Fresh air and pure water stand foremost among the substances regarded as protective disinfectants.

1.—City life demands that we live between stone walls, and that the air should have access to our apartments through narrow doors and small windows. This is true also, fortunately however, to a less degree, of residences in the country. Epidemics, except where the water supply is polluted, are most prevalent in cities. The circulation

of pure, fresh air through our living places, be they the home, workshop, or counting-room, is the best means of disinfection, and the only one capable of driving the disease germs away. Sternberg says in this connection: "The flannel rag saturated with carbolic acid and hung up in the sick room, or the chlorine saucer placed under the bed of each patient in a hospital ward, is entirely ineffectual as a disinfectant, and too often leads to the neglect of a far more important measure for ridding the air of a sick room of floating disease germs, viz., by the admission of an abundance of fresh air."[3] The presence of ozone, one of the normal constituents of the atmosphere, is an essential feature necessary for the best disinfecting power of fresh air. It has been shown by many authorities[4] that during epidemics the atmosphere is entirely devoid of natural ozone. A reappearance of ozone puts an end to the epidemic. Ozone is destroyed as fast as formed when putrescible matter is present to be oxidized.[5] Ozone is doubtless formed in every sun-lit room, and by its formation and destruction a vast amount of *materies morbi* may be destroyed.[6] Sewer gas, that hidden serpent, whose deadly poison, under many names, has been the cause of so many deaths in city homes, deserves a word. "Pure air and plenty of air is the best cure for sewer gas."[7] Pure air is said to be "the best of all disinfectants."[8] The introduction of pure air prevents the formation of a favorable environment for the development of the germ, and so the conditions essential to the formation of an epidemic become impossible. Pure air must be accepted as the most important disinfectant and preventive measure that we have.

[illegible].—Second only to pure air is pure water. It has been called "the most potent servant the sanitary authorities can call to their aid."[9] Drink only pure water; demand and insist that the household supply be of the best quality and nothing else. The origin of many of the germ diseases has been definitely traced to a contaminated water supply. "Most typhoid cases can be shown to have resulted from drinking impure water."[10] Much of the sickness during the Centennial at Philadelphia in 1876 was attributed to the water supply.[11] It will be remembered that in the history of the cholera epidemics of New York city, one of

the most infected spots was a snanty village situated west of Central Park. The cholera germs were distributed among the unfortunate squatters by the water from a single well.[12] It has been established, with some considerable degree of possibility, that the wells in certain parts of London aided in disseminating the cholera poison during successive visitations of that disease to the metropolis.[13] Sufficient data have been given to show the possibility of contamination by means of a polluted water supply. The best water for drinking purposes, and therefore the one to be considered as least likely to contain infectious material, is water which flows rapidly, and is very much disturbed, so as to be continually receiving fresh oxygen, thereby burning the organic substances by the combustion set up by oxygen.[14] R. Angus Smith says in reference to cholera germs: "It seems probable that disease cannot be carried far by pure air nor by water with much oxygen in it, which is equal to pure air." [15]

Dr. Letheby says: "The inference is that the actual agent of cholera, be it what it may, can only find congenial conditions for its full development in damp and impure air."[16] A recent paper by Pettenkofer contains this statement: "In places where cholera prevails, the water may always be indicted." [17] In plain English, then, an impure air or contaminated water supply is the essential condition for the epidemic extension of cholera. Therefore, I maintain that pure air and pure water are the most important disinfectants, for they destroy "the poisons of infectious and contagious diseases," which is our definition of disinfectants. I conclude this portion of my paper with the following aphorism from Dr. Chandler: "Pure water is hardly second to pure air as a life-giving and life-protecting agent." [18]

ARTIFICIAL DISINFECTANTS.

The artificial or chemical disinfectants constitute an important division.

So-called disinfectants are numerous, but actual experience has shown that many of the compounds highly recommended are in reality of little value. It is necessary to arrange them in classes because of their varying qualities, and also from the fact that their efficiency depends upon the conditions where they are called to disinfect. A. W.

Blyth[19] divides them into two great classes: Volatile, in form of gas or vapor; and solid or liquid.

The volatile are subdivided into:

1.—Substances which appear to form substitution compounds. These are *chlorine*, *bromine*, and *iodine*. *Chlorine* is an effectual disinfectant when present in the proportion of one part in one hundred, provided the air and the objects to be disinfected are in a moist state, and the exposure continues for upward of an hour.[20] It is prepared by the action of hydrochloric acid on manganese dioxide. One pound of the acid is used with four ounces of the oxide. Strong vinegar or dilute sulphuric acid poured on "chloride of lime" liberates free chlorine. When used in sufficient concentration, it injures colored fabrics and wearing apparel.[21]

Bromine is regarded as a good disinfectant in the proportion of one part in five hundred, the exposure continuing for upward of three hours.[20] Bromine is most conveniently used in the solid form. It is prepared by saturating a porous body, such as infusorial earth, with the liquid element.[22]

Iodine in solution is regarded as an efficient disinfectant in the proportion of one part in five hundred, the exposure to continue for two hours.[20] The solution used consists of iodine 2 grains, potassium iodide 20 grains, and water 4 ounces. Metallic iodine is sometimes employed.[21] The chlorine is generally used for fumigation. Bromine and iodine can be employed directly in the sick room. They are exposed in an open vessel at a slightly elevated temperature. Koch is credited with having written that chlorine, bromine, and iodine were among the few substances worthy of the name disinfectant.[23]

2.—Substances which probably combine chemically, and thus destroy contagion. These are *sulphurous dioxide*, *nitrogen dioxide*, and the *fumes of other anhydrous acids*. *Sulphur dioxide* (sulphurous acid), produced by burning sulphur, is still considered the only practical method of disinfecting ships, hospitals, and dwellings.[24] From one to four pounds of sulphur, according to the size of the room, are placed in an earthen vessel or iron kettle containing a small quantity of ashes and a few live coals.[25] It is best to place the vessel containing the sulphur over a tub

of water, as the presence of moisture renders it more effective, and also serves as a preventive measure in case of accident by fire. A room containing 2,000 cubic feet of air would require about four pounds of sulphur, or about three ounces to each 100 cubic feet of space. As soon as the sulphur is ignited, the room, having previously been rendered tight, should be closed, and remain so for twelve to twenty-four hours. The apartment should then be thoroughly ventilated by opening chimney draughts, windows, and doors, after which it should be scrubbed, the ceilings lime washed, and the walls repapered.[25]

Nitrogen dioxide (fumes of nitrous acid).—Toward the close of the last century this active disinfectant came into use. Hulks and prisons filled with men suffering from contagious fevers were thoroughly purified by the action of the violent fumes of this compound.[26] Its application is simple. One ounce of copper chips or filings are placed in a deep jar, and three ounces of nitric acid poured over the metal.[21] The brown colored fumes appear almost immediately. This agent is used similarly to sulphur dioxide, and it must be remembered that the fumes of both of these compounds cannot be respired, and therefore they should only be employed under the supervision of some one familiar with their properties.[27]

The fumes of *hydrochloric*, of *sulphuric*, and of *chromic acids* were experimented with by Dr. F. Crace Calvert, but found to be less powerful than the two preceding substances.[28]

3.—*Heat* and *steam* may be considered as a subdivision of their own among the volatile disinfectants. They are generally referred to as destructive agents, but I prefer to regard them as disinfectants. Fires were in early times burned in the streets of cities to dissipate the plague.[29] Heat is a good disinfectant, since none of the lower organisms can resist the temperature of 265° F. It is found that heat has the following effect on textile fabrics: They can bear 250° F., unless the heat is prolonged for several hours. A dry heat of 300° F. slightly chars cotton fabrics; at 400° F., the goods become colored dark brown; at 500° F., aseous hydrocarbons are formed; at 600° F., all vegetable and animal tissues are converted into charcoal. Aided by a jet of steam, 250° F. will, for practical purposes, be

sufficient, without destroying or injuring the texture.[30] The recent investigation, by the United States authorities, for the purpose of determining the relative value of sulphur dixoide and superheated steam used in disinfecting rags, resulted in showing that the latter agent at 320° F, applied by means of a special apparatus, was the most efficient.[31] The use of steam for disinfecting vessels has been recommended.[32] Under this head properly belong "disinfecting chambers," largely used in England and elsewhere for the purification of contaminated fabrics, bed linen, clothing, etc. It would be extending this paper to undue limits to more than mention them.[33]

4.—*The volatile oils.*—These are feeble disinfectants, and are supposed to act by oxidizing putrescible matters. This class includes such substances as *camphor, oil of hops, rue, rosemary, chamomile*, and the like. They are used directly in the sick room, and need no further description.[34]

SOLID OR LIQUID DISINFECTANTS.

This division includes:

1.—All of the soluble chlorides.

Mercuric chloride, or corrosive sublimate, is one of the most powerful disinfectants known. It is almost exclusively used by physicians and surgeons for cleaning their instruments. Koch of Berlin strongly endorses it.[35] Sternberg says, for the disinfection of clothing that can be washed, nothing better is known to science than the mercuric chloride, or corrosive sublimate. As it is a very poisonous salt, and gives no color or odor to a solution, it must be used with care and under proper supervision. It does not injure textile fabrics, and does no harm to those wearing clothing which has been disinfected by it.[34] It should be used in the proportion of one to one thousand, which is about one drachm to the gallon. Clothing should be left in a solution of this strength for at least two hours. A solution twice as strong as the foregoing can be used for the disinfection of the sputa and other discharges of cholera patients.[36]

Zinc chloride is extensively used as a disinfectant. The proportions recommended are two ounces of the salt dissolved in one gallon of water.[37] It is used for disinfecting sewerage and for cleansing clothing, bed linen, etc. A

boiling hot solution is obtained, piece by piece the articles are introduced, a thorough wetting is secured, and boiling is continued for at least an hour.[37] It must be remembered that zinc salts are poisonous. Zinc chloride has been largely employed as an antiseptic and as a preserving fluid in embalming.[38]

Aluminium chloride is regarded as the best aluminium salt for disinfecting purposes.[39] It is the important ingredient of chloralum and bromo-chloralum.[40] These substances are diluted with eight or ten parts of water, and placed in convenient vessels in the sick room, or towels saturated with the solution are suspended in the apartment. One of the advantages of these compounds is their freedom from odor.[21]

Iron chlorides.—In a report addressed to the Metropolitan Board of Works in 1859, Drs. Hofmann and Frankland stated that ferric chloride "is the cheapest and most efficient deodorizer that could be applied to sewerage."[41] Ferrous and ferric chlorides are serviceable for disinfection of privies, sewers, etc.[42]

Manganese chloride, a substance frequently thrown away, has been shown by Gay-Lussac and Young to possess valuable preserving powers.[43]

Lead chloride.—Dissolve 36 grains of the lead nitrate in two pints of water, and 120 grains of common salt in three gallons of water. Pour these together and allow them to settle, and you will have a definite saturated solution of the lead chloride, which contains no more of the salt than is necessary to decompose fœtid gas, and is not poisonous.[44]

All that is required to immediately purify and sweeten a contaminated air supply, however originated, is to dip a cloth in the liquid, and hang it up in an apartment. Its action consists in combining with the sulphur and organic compounds. *Copper chlorides*, as well as most copper salts, are excellent antiseptics, and therefore are of value as disinfectants on account of their preserving power.

Sodium chloride, on account of its cheapness, is a valuable disinfectant. It acts principally as an antiseptic, but its freedom from odor, its easy solution, and being always obtainable, we cannot but accept it as a useful household disinfectant.

Twenty-four ounces to a gallon of water, or a handful or

so to a pail of water, are the best proportions for ordinary use. It can be employed for cleansing sinks, for privies, and also for washing purposes. Other *chlorides* are doubtless of value, but those mentioned are the most important.

2.—All soluble sulphates.

Iron sulphate (copperas) is for most purposes the best recommended of active disinfectants. For cholera it is strongly endorsed by Pettenkofer as an addition to the discharges of the patient.[45] It is both cheap and effectual for the suppression of odors. From one-half to one and a half pounds dissolved in a gallon of water is considered the most desirable proportion to use.[46] The addition of ten per cent. of carbolic acid is advised when a deodorizer is desired.[47] This disinfectant is specially commended for use in privies, cesspools, drains, sewers, and all vessels and places receiving the discharges of the sick. As it produces a brown stain, it cannot be used for washing linen, floors, or walls.[48]

Zinc sulphate (white vitriol) is of importance. Its preparation and application are identical with zinc chloride, already described.[49]

Aluminium sulphate (alum) is more of an antiseptic than a disinfectant, and is considered inferior to the aluminium chloride.[49a] It has recently been highly recommended by Prof. Beilstein.[50]

Copper sulphate is used in connection with other sulphates in the preparation of certain disinfectants.[51] It belongs to the antiseptic class. *Manganese sulphate* is used to a slight extent.[52] The foregoing are the most important disinfectants of the sulphate group. A solution of one part of a metallic sulphate in 250 parts of an organic solution will prevent the manifestation of infusorial life.[53]

3.—All soluble sulphites. This group possesses in a marked degree the properties of sulphur dioxide. They are seldom used, except for the deodorization of stables and manure heaps.[54]

4.—Certain of the acetates. *Iron Acetate.* This salt is naturally less valuable than the sulphate or chloride.[55] *Lead acetate* is used to a slight degree.[56] *Aluminium acetate*[57] is used. It prevents putrefaction, and therefore belongs to the antiseptics.

5.—Some few of the nitrates are used as disinfectants.

Lead nitrate,[58] referred to under lead chloride (see *ante*). *Potassium nitrate*[59] (saltpetre) is used to preserve food. It is sometimes employed as a disinfectant. *Sodium nitrate* has the same properties as the potassium salt.

6.—Certain agents which appear to arrest putrefaction without either destruction or oxidation. These are principally *carbolic acid*[60] and other *tar acids*. As to whether this class deserves our attention at all is a question difficult for decision. On one hand, it is said that carbolic acid will kill the miscroscopic organisms of putrefaction, and for this reason it has had extensive application in surgery, but lately it has been largely superseded by other compounds. While, on the other hand, Dr. Koch of Berlin finds it to be fifteen hundred times less powerful in destroying micro-organisms than mercuric chloride.[61] Its chief value is as an antiseptic.

7.—Preservative liquids and solutions. Many of these act by coagulating the albumen of organized bodies. This group includes the *antiseptics*, *alcohol*, etc. Among the prominent antiseptics are benzoic acid and benzoates, borates, as aluminium borate, etc., borax, boro-glycerides, formic acid, picric acid, pyrogallic acid, resorcin, salicylic acid, etc. It is impossible to undertake to discuss their relative merits at this place. It must be recollected, however, that as they prevent putrefaction, so in a measure they are disinfectants.

8.—Agents which, in many ways, partly by absorbing moisture, partly by condensing gases, and partly by a peculiar action on organic matter analogous to tannin, act as disinfectants.

The most important of this group is dry earth. In fact, it bears a close relation to the natural disinfectants, for it is in conjunction with each other that air and soil best disinfect.[62]

Quicklime,[63] *calcium sulphate*[64] (gypsum or land plaster), and *charcoal* are likewise members of this class. They are used principally out of doors, and are of great value in absorbing putrid gases, moisture, and putrid fluids. Their function is essentially the absorption of those noxious materials that, if otherwise ignored, might form a suitable environment for the development of disease. The action of charcoal in filtering water may be regarded as disinfect-

ing. Suspended in a basket in cisterns, meat safes, dairies, etc., it tends to keep the contents from absorbing foul odors.[65]

9.—There are several important disinfectants that thus far have not been referred to. While they do not form a class by themselves, they are grouped in this *omnium gatherum* for a word or two. *Hydrogen peroxide* is an exceedingly valuable disinfecting agent. It oxidizes organic matter, and from this quality deserves important consideration. It has found favor in surgical operations as an antiseptic and disinfectant.[66] Hydrogen peroxide is free from odor, and is harmless to all textile fabrics.

Potassium permanganate, on account of the oxygen which it contains, is a useful disinfectant.[67] *Sodium permanganate* has also been used.[68]

Chlorinated lime,[69] or "chloride of lime," together with the *hypochlorites*, are most excellent disinfectants. These compounds owe their efficiency to the chlorine which they contain. They act by destroying fœtid gases; they check putrefaction, and serve as germicides. A solution of "chloride of lime," made by straining or decanting a gallon of water into which a pound of the lime has been dissolved, forms a convenient disinfectant for the sick room. The addition of strong vinegar or dilute sulphuric acid increases its power. Vessels may be washed with it, but textile fabrics become injured.[71] The value of the *sodium hypochlorite* (Labarraque's solution) has long been known. Dr. Duggan has recently experimented with the potassium and the calcium hypochlorites.

Carbon disulphide has been recommended as a disinfectant powerful enough to destroy the contagion of cholera germs. Its use as an insecticide, especially against the phylloxera in France and in California, is well known.[72]

This discussion of the various disinfectants—already too prolonged—must now be brought to an end. An earnest effort has been made to point out those substances which, either from actual experience or upon theoretical grounds, seem worthy of consideration. Great care has been taken to introduce only such statements as are trustworthy, and therefore this paper has been supplemented with a series of notes giving authorities. In every case the evidence

offered is reliable. But as the progress of science advances, opinions change or are modified, and therefore conflicting statements may be found. As far as possible, the notes have been made to include working formulas which, it is trusted, will be found suggestive to practical pharmacists.

NOTES.

[1]. Cf. Geo. M. Sternberg, Our Invisible Foes, p. 29. A paper read before the Military Service Institution, Jan. 8, 1885.

[2]. Instructions for Disinfection. Prepared for the National Board of Health, 1879.

[3]. Our Invisible Foes, p. 34.

[4]. Lillard, Wolf, Boeckel, Strambers, Hammond, Leeds, Barker, Jacoby. See pamphlet on Atmospheric Purification by Electricity, by Henry A. Mott, Jr., Ph.D., F.C.S., etc.

[5]. Ozone, R. C. Kedzie, Michigan State Board of Health Report, 1875, p. 139.

[6]. Flowering plants yield ozone. Their cultivation in living rooms is most earnestly recommended as one of the most efficient means of destroying disease germs. Ozone machines are on the market.

[7]. C. F. Wingate, in Sanitary Tract No. 4, on Sewer Gas and Bad Plumbing, issued by the Citizens' Sanitary Society of Brooklyn.

[8]. Disinfectants and Deodorants, Druggists Circular, July, 1879.

[9]. C. F. Chandler, Pres. N. Y. Board of Health. Lecture on Water, delivered before the American Institute, p. 45.

[10]. Report of Michigan Board of Health, 1875, p. 65. See also Failure to Prevent Deaths, p. 81, same volume.

[11]. See Observations on the Water Supply of Philadelphia, by Reuben Haines, Jour. Franklin Institute, April, 1881. Mr. Haines published several papers bearing on this subject, which were afterward reprinted in the Chemical News, of London.

[12]. Report upon the Sanitary Chemistry of Waters, C. F. Chandler, p. 9 of his reprint from vol. 1, Public Health Papers of American Public Health Association.

[13]. Idem., p. 15.

[14]. I desire to most thoroughly endorse that series of

simple tests for potable waters issued by the Michigan State Board of Health. They can be found reprinted in Indoors and Outdoors, vol. 2, No. 1, p. 6.

[15]. Report of Royal Commission on the Water Supply of London, 1869.

[16]. Idem.

[17]. Cholera: Its Mode of Propagation. Pop. Sci. Monthly, vol. 26, p. 626. by Dr. Max von Pettenkofer.

[18]. See note 8, same reference.

[19]. Same reference as 2. A Dictionary of Hygiene and Public Health. including Sanitary Chemistry, by A. W. Blyth, London, 1876.

[20]. Value of Popular Disinfectants. Druggists Circular. p. 70, April, 1885.

[21]. Disinfectants and their Special Application. by E. L. Griffen. Pres. State Board of Health. Wisconsin. Sci. Am. Sup., vol. 7, p. 2583, No. 162.

[22]. "The bromine is soaked up by infusorial earth. and is conveniently placed in a Bruner's pan of glass or porcelain. instead of lead. having a very deep depression in the cover. The water sealing the joint of the lid becomes charged with bromine from the interior. whence the bromine gradually diffuses into the room. To accelerate the rate of diffusion. warm water may be poured into the depression in the centre of the cover. Petroleum is recommended to reduce the action of bromine on organic substances with which it may come into contact. or to quickly remove the odor."—Dingler's Poly. Jour.. 249, p. 167. (abstracts of chemical papers); Jour. Chem. Soc.. 46, p. 512. 1884.

"The use of chlorine and, in a greater degree. of bromine, requires considerable experience in management; when carelessly handled, they may cause inconvenient and even dangerous symptoms in persons using them. For these reasons they are not suitable for popular use."—Tests of Chlorine, Bromine. and Iodine by Professor Geo. H. Rohé; A Report to the Committee on Disinfectants of the American Public Health Association.

[23]. N. Y. Times. Science Notes, April 22, 1883. Cf. Spons' Workshop Receipts, 2d Series, p. 196.

[24]. Our Invisible Foes, by Geo. M. Sternberg, p. 36. Sternberg also says that "the power of this agent (sulphur

dioxide) to destroy micro-organisms has been overestimated;" and I find that recent experiments by Dr. Wolfhügel at the Laboratory of the Board of Health at Berlin show that "on spores it has, whether as gas or in solution, even in the highest concentration, no influence whatsoever." Pasteur and others still maintain the value of the sulphur dioxide. See Experiments in Disinfection, in Druggists Circular, October, 1879, and, more recently, French Experiments in Disinfection, in N. Y. Commercial Advertiser, August, 1884, from London Times of July, 1884.

[25]. Cf. also the Instructions for Disinfections prepared for the National Board of Health, 1879.

[26]. Cooley's Cyclopædia of Practical Receipts, vol. 1, p. 565, 6th ed., N. Y., 1879.

[27]. "A commission of the French Academy report that nitrogen dioxide is the most potent disinfectant, being greatly superior to every other substance as regards its action on infectious germs. The gas is applied by mixing in a two gallon stone vessel two quarts water, three and one-fourth pounds ordinary commercial nitric acid, and one-half pound copper turnings. The gas thus evolved is sufficient to disinfect a room containing 30 to 40 cubic yards; the crevices in the door should be covered over with gummed paper to avoid loss of fumes; when forty-eight hours have elapsed, the doors are unsealed by a man protected by a suitable respirator, and the room is well ventilated."—Spons' Workshop Receipts, 2d Series, p. 199.

[28]. See table of experiments contained in Cooley's Cyclopædia, p. 563.

[29]. Johnson's New Universal Cyclopædia, vol. 1, p. 1361, article on Disinfectants.

[30]. Druggists Circular, article on Disinfectants, August, 1878.

[31]. Disinfection by Steam, p. 253. (Of some recent medical journal. My clipping is without the name. The facts are well known, however.)

[32]. An Experiment in Disinfection of Sailing Vessels by Steam, by Richard A. Cleeman, Medical Times, p. 61, Nov. 8, 1879.

[33]. See articles on Disinfecting Chambers, Cooley's Cyclopædia, p. 569; Disinfecting Stoves, Encylopædia of Chemistry, vol. 1, p. 618, Philadelphia, 1877; and Ap-

paratus for Hospital Disinfection. Sci. Am. Sup., vol. 11, p. 4178, No. 252.

[34]. The following typical illustration of a mixture representing this class has been recommended for hospital use: One part of rectified oil of turpentine, 7 parts of benzine, with the addition of 5 drops of oil of verbena to each ounce.

[35]. Same reference as 23

[36]. The Bellevue Disinfectant, sold in New York, is said to be a one per cent. solution of mercuric chloride.

[37]. Same reference as 25

[38]. Among the zinc chloride disinfectants, we find the following:

In the German army a solution of one part of zinc chloride to 240 of water is used for washing infected clothing.

Sir Wm. Burnett's disinfecting fluid is a concentration of zinc chloride. It is prepared by dissolving zinc in commercial hydrochloric acid to saturation.

[39]. The American Cyclopædia, vol. 6, p. 134, article on Disinfectants.

[40]. The Chloralum is a liquid disinfectant, consisting of aluminium chloride, 20 ounces, and calcium sulphate (gypsum), 1–3 ounce.

Bromo-chloralum is composed of 13 ounces of aluminium, with traces of bromine, calcium sulphate, etc.

[41]. Cooley's Cyclopædia, p. 562.

[42]. Johnson's Cyclopædia, p. 1361.

The two following liquid disinfectants; are by-products obtained in detinning scrap tin-plate:

De Wessley's Solution:

Ferrous chloride........................	25	ounces.
Ferrous sulphate........................	8	"
Zinc chloride............................	15	"

in one gallon water.

Liquid of Manhattan Metal and Chemical Company.

Ferrous chloride........................	10	ounces.
Zinc chloride............................	36	"

dissolved in one gallon water.

[43]. Dr. Ure's Dictionary of Arts, Manufactures, and Mines, vol. 2, p. 41, seventh English edition, 1878

Ellerman's Deodorizing Fluid is said to consist chiefly of the perchlorides and chlorides of iron and manganese.

[44]. New Remedies, January, 1877.

Lead nitrate acts similarly, and its preparation is the same.

[45]. Cooley's Cyclopædia, p. 566.

[46]. Same as 25.

[47]. Same as 21.

[48]. Siret's Disinfecting Compounds are :

a. A mixture of calcium sulphate, 53 lb.; iron sulphate, 40 lb.; zinc sulphate, 7 lb.; and peat charcoal, 2 lb., made into balls.

b. Iron sulphate, 20 parts ; zinc sulphate, 10 parts ; tan or waste oak bark (in powder), 4 parts ; tar and oil, of each, 1 part ; as before. Used for deodorizing cesspools, etc.

Bayard's Disinfectant is a mixture of copperas, clay, lime, and coal tar.

Among other solid mixtures are :

Iron sulphate (copperas)	300 parts.
Calcium sulphate (gypsum)	100 "
Carbolic acid	2 "

Also

Iron sulphate	20 parts.
Calcium sulphate	36 "
Zinc sulphate	1 "

The Excelsior Disinfectant.

Ferrous sulphate	5 ounces.
Sodium chloride	3 "
Sulphur	1¼ "

In liquid form there is—

Monsel's Solution, consisting of :

Ferric sulphate	59 ounces.
Ferric nitrate	21 "

to each gallon of water.

Farwell's Disinfectant is :

Ferrous sulphate	17 ounces.
Carbolic acid (about)	5 "

dissolved in one gallon of water.

Mettenheimer's Disinfectant Fluid.

Ferrous sulphate	8½ ounces.
Carbolic acid (about)	7 "

dissolved in one gallon of water.

Dung & Son's Solution.

Ferrous sulphate	5 ounces.
Carbolic acid (about)	7 "

dissolved in one gallon of water.

[49]. *Contaret's White Fluid* consists of 10½ ounces zinc sulphate dissolved in one gallon of water.

The *Girondin Disinfectant* contains in each gallon:

Zinc sulphate	33 ounces.
Copper sulphate	2 "
Calcium sulphate	1 "

Also

Zinc sulphate	8 parts.
Carbolic acid	1 "
Water	300 "

The National Board of Health recommends zinc sulphate and common salt dissolved together in water in the proportion of four ounces of the sulphate and two ounces salt to the gallon of water.

The Board of Health of New York city endorse zinc sulphate, 8 ounces, crude carbolic acid, 1 ounce, warm water, 3 gallons, as an excellent disinfectant for the sick room. As a washing solution for infected clothing, a preparation of one part of zinc sulphate to 120 of water is used in the German army.

[49a]. Ure's Dictionary, p. 41.

[50]. "In a communication to the St. Petersburg Technical Society, Prof. Beilstein recommends the use of aluminium sulphate as the best practical disinfectant." —Boston Jour. of Chemistry, May, 1881. See also Spons' Workshop Receipts, 2d Series, p. 199: "The best means of providing it is to make a mixture of red clay with four per cent. of sulphuric acid, and to add to this mixture some carbolic acid for destroying the smell of the matter which is to be disinfected."

Dr. Bond's Ferralum is a mixture of ferrous and aluminic sulphates, turpentine, and carbolic acid. Its

chief use is for deodorizing cesspools, urinals, etc., and for flushing sewers.

[51]. Dr. Bond's Cupralum is stated to be a mixture of the sulphates of copper and aluminium with potassium bichromate and turpentine.

Larmande's Antimephitic Liquor is a solution of the zinc and copper sulphates.

[52]. Seeley's sulphate of manganese is a solution containing in each gallon of liquid :

Manganese sulphate	17	ounces.
Ferric sulphate	8	"
Free sulphuric acid	11	"
Free hydrochloric acid	2	"

[53]. Encyclopædia of Chemistry, p. 617.

[54]. "The peculiar actions of sulphites and carbolic acid have been united in that called, 'McDougall's Disinfecting Powder,' where it is desirable not to use liquids, these two have been united into a powder, which assists also in removing moisture, as water is often a great cause of discomfort and disease in stables and cow houses."—Ure's Dictionary, p. 40.

[55]. Ure's Dictionary, p. 41.

[56]. In a common black wine bottle full of cold water dissolve two ounces of lead acetate, and then add two fluid ounces of nitric acid. Shake the mixture well, and it is ready for use. A very small quantity of it will cleanse any utensil, and a room can be thoroughly disinfected by it, using cloths dipped in the liquid diluted with eight parts of water.

[57]. Note in New Remedies taken from Pharm. Centralhalle, p. 361, 1878.

[58]. Ledoyen's Disinfecting Fluid consists of a solution of one part lead nitrate in about eight parts of water. This can also be prepared by dissolving 13½ ounces of litharge in 12 ounces of nitric acid previously diluted with 6 pints of water.

[59]. Ure's Dictionary, p. 41.

[60]. Sternberg says in his recent report (Medical News, vol. 46, p. 146, February 7, 1885) : "Impure carbolic acid or the volatile constituents of tar can have no great value in view of the low disinfecting power of these agents." Also

see Blyth's report at same place on various tar acid disinfectants. I add the following receipt for a disinfectant, furnished the office of the Quartermaster-General, United States Army, by the Medical Department :

"One part of Calvert's No. 5 carbolic (phenic acid), 20 parts of commercial iron sulphate, 100 parts of water, by weight.

"In cases requiring the most energetic disinfection, ten parts of the crude commercial zinc chloride by weight will be substituted for the twenty parts commercial iron sulphate."

The following solutions of carbolic acid are on the market :

Grantville Carbolic Alkali was found to contain in one gallon of liquid 6 ounces of carbolic acid and 2½ ounces of potassium hydroxide (potassa).

Phenol Sodique is said to be 1 2-3 ounces carbolic acid to the gallon.

Squibb's solution has been found to contain 2¼ ounces of carbolic acid to the gallon.

[61]. See table in Spons' Workshop Receipts, 2d Series, p. 196.

[62]. Ure's Dictionary, p. 36.

[63]. "Lime is used for precipitating sewerage water, and acts as a disinfectant, as far as the removal of the precipitate extends, and also by absorbing hydrogen sulphide, which, however, it allows again to pass off gradually." —Ure.

Griffen recommends it pulverized and scattered over places to be dried. In damp rooms it should be placed in pans in liberal quantities. Mixed with water it is used to limewash walls and ceilings. It is useful when spread over heaps of fresh manure as a preservative.

[64]. Gypsum is used principally in conjunction with other disinfectants.

The following are several illustrations of the solid disinfectants.

The figures represent in round numbers the quantity found in a pound of each article.

Carbolate of lime.

Lime	10	ounces.
Magnesia	40	grains.
Sand, iron, etc	48	"
Carbolic acid	31	"

Carbolate of lime (another make).

Lime	9⅓	ounces.
Magnesia	½	"
Sand, iron, etc	½	"
Carbolic acid	31	grains.

Phœnix Disinfectant.

Clay	9	ounces.
Ferric chloride	83	grains.
Ferric oxide	1	ounce.
Lime	½	"
Carbolic acid	26	grains.

Egyptian Disinfectant.

Sand	11½	ounces.
Alumina	2½	"
Lime	26	grains.
Carbolic acid	22	"
Dead oil	1	ounce.

[56]. Dr. Stenhouse recommends as a cheap and very efficient deodorizing agent, "aluminized charcoal." It is prepared by dissolving 54 parts of the commercial aluminium sulphate in water, and mixing with it 92½ parts of finely powdered wood charcoal When the charcoal is saturated, it is evaporated to dryness and heated to redness in covered Hessian crucibles till the water and acid are dissipated. The charcoal contains 7½ per cent. of anhydrous alumina.

[56]. See Notes on Peroxide of Hydrogen as a Disinfectant and Deodorant, Sci. Am. Sup., vol. 7, p. 2646, No. 166. Also, Peroxide of Hydrogen (Oxygenated Water), and its Employment in Surgery, etc., by C. T. Kingselt, Weekly Drug News and American Pharmacist, vol. 6, p. 68. Also, The Peroxide of Hydrogen, Medical News, vol. 46, p. 160. Dr. Wollain says, "It is said to have active germicide and antiseptic effects, and be 40 per cent. stronger than mercuric chloride."

Sanitas is a new English antiseptic and disinfectant containing hydrogen peroxide and camphoric acid, and obtained by the atmospheric oxidation of turpentine. (Cooley.)

[57]. "Potassium permanganate is under certain circum-

stances an excellent disinfectant."—Appleton's Cyclopædia, vol. 6, p. 134.

[68]. Spons' Workshop Receipts, 2d Series, p. 201.

[69]. "Eckstein finds that chlorinated lime is the most effective disinfectant for privies, urinals, etc. It is conveniently applied in a bag made of parchment paper through which the disinfectant slowly passes by osmosis." —Spon.

Collin's Disinfecting Powder is a mixture of dry chlorinated lime, two parts, and burnt alum, one part. Use either dry or moistened with water.

[70]. Griffin's article ; see Note 21.

[71]. Appleton's Cyclopædia, vol. 6, p. 134. See also Sternberg, Medical News, p. 146.

The commercial Labarraque's Solution contains about 2 ounces available chlorine to the gallon of liquid. See also Druggist's Circular, p. 71, April, 1885.

[72]. Report on the Germicide Power of the Hypochlorites, Medical News, vol. 46, p. 147, by Dr. J. R. Duggan.

[73]. See Druggists Circular, p. 30, February, 1885. Also, Cooley's Cyclopædia, p. 562.

CHARCOAL.

DISINFECTANTS AND THEIR USE.

No. 7.

CLEANLINESS AND CHLORINE

In a matter which concerns the health and the lives of the people, and appeals to the interests of every home in the land, what is to be done to teach the truth and the facts? There has been too much technicality and science, and too little simplicity and common sense, in the literature of disinfectants widely disseminated among the masses. They know from observation, reading, and experience, that filth, animal and vegetable matter, under certain conditions of heat and moisture, decay or putrefy, and that this promotes the growth of disease. Cellars, yards, garbage-boxes, cess-pools, and sewers are the places, of all others, to be constantly cleaned and disinfected. Assuming all reading and thinking people know and appreciate the disinfecting value of sunshine, fresh air, pure water, and *fire*, to burn all sources of disease-producing matter whenever practicable, what substance, natural or artificial, can be used, that is abundant, cheap, and good, which applied to filth will prevent sickness and lessen the death-rate—a true disinfectant that has stood the test of time, and can stand the test of the chemist?

Chlorine is that substance, and its compounds are invaluable. It was discovered by Scheele in 1774, viewed as a simple body by Guy-Lussac and Thenard in 1809. This was confirmed by the experiments of Sir Humphry Davy, published in the *Transactions* of the Royal Society, 1808–09–10–11, who named it chlorine. The following matter from the *American Farmer*, Baltimore, Md., originally published in the *Cambridge Chronicle*, February 18, 1830, in view of the present use of "chlorine compounds," may prove interesting. It was written by a contemporary of Scheele, Gay-Lussac, Thenard, and Sir

Humphry Davy, Dr. Jos Ennalls Muse, of Cambridge, Md. He was an A.M. of Yale College, and an M.D. of Jefferson Medical College, an intimate friend of Professor Silliman, editor of the *American Journal of Science*, also of John S. Skinner, who established the *American Farmer* in 1819, the first agricultural journal in the country, at his suggestion. He declined the chair of chemistry in the University of Maryland, and also resigned his seat in the Maryland Senate, at a period in his State's history when it was the summit of every gentleman's ambition to secure and retain one, to devote his life to literature and science. He had a laboratory liberally furnished with apparatus for experimental investigation, and a library not surpassed in the State for the scientific value of its contents. His ample home and several farms were all at times, used for various scientific work in agricultural chemistry and other matters.

With this view and these sentiments, I make the communication of a "*fact*" which should be cut out and pasted in every man's parlor. The fact that I allude to has been recently ascertained by a French chemist and surgeon, M. Coster, and published in the *American Journal of Science*, conducted by Professor Silliman. This important fact, "*that chlorine has the power to decompose and destroy the deadly poison of the mad dog!*" has grown out of chemical philosophy and chemical research, and is of more value than vaccination, or any other discovery which the annals of medicine have recorded; because it furnishes man with a certain prophylactic against the most horrible disaster which is incident to his existence.

Of the truth of this discovery, and the accuracy of the experiments on which the statement is predicated, there can be no doubt. "It is affirmed" by the most highly valued medical authority; and M. Gay-Lussac has since reported a case of the successful application of the same substance to poison by prussic acid, one of the most active and virulent known in nature; and it will be probably extended to many others. It is astonishing that this substance, called "chlorine" under the new nomenclature, should have remained so long comparatively at rest. It was discovered by Scheele in 1774, and was used many years ago by England and, I believe, France, to

purify their ships, jails, and hospitals, under the name of oxy-muriatic gas! The principle, too, on which it operated was *then* well understood; and the theory now differs in the present case chiefly in *terms*. Hydrogen gas is known to constitute, in combination with sulphur, phosphorus, and ammonia, the intolerable smells from putrefying substances; deprived of hydrogen, this odor disappears; the analogy was extended to animal effluvia; the conclusion was drawn that the abstraction of the hydrogen by means of its affinity for the excess of oxygen in the oxy-muriatic gas would destroy the virus by its decomposition; the result has been satisfactory. The Chloridians view this same oxy-muriatic gas as an elementary substance, and call it "chlorine," from its green color; this "chlorine," then, performs the part of the oxygen of the "French theory," and, combining with the hydrogen of the effluvia, effects its decomposition and consequent destruction in the same manner.

As many poisons (most probably all animal *poisons*) are known to contain hydrogen, it is a matter of astonishment that analogical induction had not long ago advanced the learned inquiries to the present important discovery, "that poisons, animal and mineral, constituted in part of hydrogen, as far as experiment has gone, are decomposed and rendered innocent by oxy-muriatic gas, or chlorine, as the respective theorists may please to have it."

This article (chlorine) is cheap, and should, in conjunction with the mode of using it, be in the possession of every family, because delay will render it abortive. It is prepared and applied in the following manner: Make a strong wash, by dissolving two tablespoonfuls of chloride of lime in half a pint of water, and instantly and repeatedly bathe the part bitten. The poison will, in this way, be decomposed. It has proved successful when applied within six hours after the animal has been bitten.

It may be now proper to say that I have made this communication because the fact stated is one of recent discovery; and I have made it the more full, connecting with it the *rationale*, that it may obtain the greater confidence with those who, though not conversant with chemical science, yet can appreciate the force of reason in any science; and I have affixed my name, because an anonym-

ous notice of a fact does not necessarily bear with it the verity or responsibility of a name.

I have the honor to be, sir,

Yours, etc.,

JOSEPH E. MUSE.

Webster, edition 1880, defines "Disinfectant: That which disinfects; an agent for removing the causes of infection, as chlorine." "Chlorine: It is a powerful bleaching and disinfecting agent." Worcester, edition 1881, defines "Disinfectant: A substance which prevents infection; 'Chloride of lime is a disinfectant.'—P. Cyc . . Chlorine: 'It is a powerful bleaching and disinfecting agent.'—Ure." It appears that these famous lexicographers, whose books are authority among scholars, and affect profoundly our pronounciation by their differences of opinion, got their information from Ure, and Worcester gives it proper credit —Ure's "Dictionary of Chemistry": "Chlorine is the most powerful agent for destroying contagious miasmata."

"The American Cyclopædia," "Disinfectants": 'Chlorine' acts as a most powerful disinfectant. 'Chlorine' is a most efficient agent in decomposing putrid and noxious vapors and gases. It is largely employed as a disinfectant." "Encyclopædia Britannica," under Disinfectants, gives high place to "chlorides." Dunglison's "Medical Dictionary," Philadelphia, revised edition, 1868: "Chlorine: It is employed in fumigations as a powerful disinfecting agent." "United States Dispensatory," Wood & Bache, fourteenth edition, Philadelphia, 1879: "In consequence of its powers as a disinfectant, chlorinated lime is a very important compound in its application to medical practice. It possesses the property of arresting animal and vegetable putrefaction, and, perhaps, of destroying pestilential and infectious miasms. In juridical exhumations its use is indispensable. It is employed also for disinfecting dissecting rooms, privies, common sewers, docks, and other places with offensive effluvia. In destroying contagion and infection, it appears to be highly useful; and hospitals, alms-houses, jails, ships, etc may be purified by it. In short, all places deemed infectious from having been the receptacle of disease, may be more or less disinfected by its use, after having undergone the ordinary

cleansing." Dr. Ure's "Dictionary of Arts, Manufactures, and Mines," by Hunt and Rudler, seventh edition, London, 1875: "The value of chlorine as a deodorizer and disinfectant consists also in its power of decomposing water and setting free oxygen, which then oxidizes the poisonous miasmatic exhalations and converts them into more or less innocuous products."

Brande & Cox, "Dictionary of Science, Literature, and Arts," London, 1865: "Chlorine destroys the putrid odor of decomposing vegetable and animal substances, and infectious effluvia of all kinds, whence its use in fumigations, and in preventing the spread of infectious and contagious matter, and purifying noxious atmospheres. The great natural source of chlorine is common salt, which contains it in the proportion of about 60 per cent."

Rodwell's "Dictionary of Science," Philadelphia, 1873: "Its affinity for hydrogen is one of its strongest characteristics. It decomposes with separation of oxygen, and thus indirectly acts as a powerful oxidizing agent; hence, chlorine is of great value in destroying organic coloring and other matters, and also as a bleaching and disinfecting agent.

Booth's "Encyclopædia of Chemistry": "Chlorine is likewise useful for the purpose of fumigation, by destroying the volatile principles given off by putrefying animal matter."

Miller's "Inorganic Chemistry," 1871: "This energetic action of chlorine renders it of great value as a disinfectant, for it immediately decomposes all animal effluvia with which it comes into contact, and converts them into new and harmless substances." "Inorganic Chemistry," Dr. Wilson's, 1868, Professor of Technology, University of Edinburgh, revised by Macadam, Lecturer on Chemistry, Medical School, Surgeons' Hall, and to the School of Arts, Edinburgh: "A property of chlorine, not less important than that of bleaching, is the power it possesses of destroying animal effluvia and offensive odors. It is of great service, accordingly, as a disinfectant in fumigating apartments in which noxious animal matters have collected, or persons have resided while suffering from infectious diseases. It admits of valuable application also for the purification of the air of sick-chambers while oc-

cupied by invalids. The chlorine is evolved, in the latter circumstance, by placing chloride of lime in an open vessel exposed to the air. Chlorine may, in this way, be set free in sufficient quantity to destroy unpleasant effluvia without occasioning annoyance to the patient." Roscoe and Schorlemmer, "Chemistry," Professors of Chemistry, Owens College, Manchester, England, 1878: "Chlorine also possesses powerful disinfecting properties, and the gas is largely used for the destruction of bad odors, and of the poisonous germs of infectious diseases, floating either in the air or in water. It is probable that this valuable property also depends upon the oxidation, and consequently the destruction, of these poisonous emanations and miasmata." "Inorganic Chemistry," H. Watts, London, 1883: "Chlorine is also one of the best and most potent substances that can be used for the purpose of disinfection. For purifying an offensive or infectious atmosphere, *as an aid to proper ventilation*, the bleaching powder is very convenient." "Chemistry," Clarke's, 1884: "Chlorine is also a vigorous disinfectant. This property, and its value as a bleaching agent, both depend upon its strong affinity for hydrogen."

Wurtz's "Elements of Chemistry," by Green, second American edition, translated from fifth French edition, 1884, Senator and Professor of Chemistry, Faculty of Medicine, Paris: "All organic substances contain hydrogen; they are, therefore, generally modified and often destroyed by the action of chlorine. Chlorine is also an efficacious disinfectant. It decomposes hydrogen sulphide. It destroys odorous matter of organic origin, the effluvia resulting from putrid fermentation, and the miasms which are sometimes diffused in the air. It is employed to disinfect privies, etc., and to purify the air in certain epidemics. The bleaching and disinfecting properties of chlorine are due to the same cause, its powerful affinity for hydrogen."

Adolph Strecker's "Organic Chemistry," by Dr. Johannes Wislicenus, Professor of Chemistry, University of Würzburg, translated and edited by Hodgkinson and Greenaway, New York, 1882: "Putrefaction, decay, and fermentation of organic bodies are prevented by common salt (chlorine and sodium) in concentrated solution. In order to preserve anatomical preparations, they are treated

with solutions of mercuric chloride (chlorine and mercury), zincic chloride (chlorine and zinc), etc.

"Chemistry of Common Life," Johnston, 1873, twelfth edition: "This gas decomposes sulphuretted hydrogen, ammonia, and nearly all the other gaseous compounds and evil smelling vapors which escape from decomposing animal and vegetable matters. It acts, indeed, upon all organic substances, almost without exception. Chlorine has been long employed as a remover and destroyer of unpleasant smells. It is probably the most generally efficient for this purpose of any gaseous substance with which we are acquainted; and, besides its efficiency, it is further recommended by being easily and cheaply prepared, by producing its good effects even when diluted with much air, by being breathable, when so diluted, without injurious effects. It can thus be used within a building without displacing its inhabitants, and with little inconvenience, even in the chambers of delicate invalids. In this dilute state, also, its use is free from almost every other objection. Chloride of lime possesses the chemical qualities of an efficient disinfectant in a high degree. It consists of lime and chlorine; of these the lime combines with all the acid bodies represented by the sulpuretted hydrogen, while the chlorine either combines with or decomposes the alkaline compounds represented by ammonia. It is, therefore, generally and deservedly esteemed as one of the best, most efficient, and most manageable of our solid disinfectants. Spread in the solid form upon any fermenting mass, it destroys the obnoxious bodies as they are formed. Dissolved in water and sprinkled over bad-smelling chambers, or mixed with more or less fluid collections of putrid matter, it brings sweetness everywhere. Fœtid odors and poisonous qualities alike disappear before it. Only its comparatively high price prevents its being employed for sweetening our common sewers, garbage-boxes, and cesspools. (The "high price" mentioned in 1873 does not now exist.) The results of its action have the further advantage that they are not offensive either to sight or smell."

Dr. Muse's opinion of chlorine as a remedy for the bite of a mad dog, published in 1830, has been recently endorsed by the experiments of Professor Binz, of Bonn, and

published in the *Lancet*, London, and *Scientific American*, New York, 1883. A disinfectant capable of destroying the poison of hydrophobia is worthy of confidence. The National Board of Health, a few years since, made the most extensive experiments with disinfectants in the South to suppress the yellow fever, and chloride of lime maintained its high place. The American Public Health Association, at their last meeting, appointed a committee of scientific men to investigate thoroughly the subject of disinfectants. Dr. G. M. Sternberg, U. S. Army, chairman of the committee, with others, did the experimental work in the biological laboratory of the Johns Hopkins University, and recommended what they call standard solution No. 1: "A solution of chloride of lime (bleaching powder), made by dissolving four ounces of chloride of lime of the best quality in one gallon of water. It is especially recommended for the disinfection of the excreta of cholera, typhoid fever, diphtheria, dysentery, yellow fever, scarlet fever, and other kindred diseases, about one pint of the solution to each discharge."

With such evidence to confirm every day experience that filth begets, and cleanliness and chlorine prevent, disease, is it necessary to refer to such authorities as Orfila, Lesure, Gerdy, Hennelle, Gautier de Claubray, or, more recently, Abel and Bloxham, Elliot and Storer, Gregory, Griffin, Fownes, Wells, Regnault, of France Stökhardt, and Wagner, of Würzburg. The death-rate per thousand of London is 21; Berlin 26; Paris, 26; Dublin, 27; Vienna, 29; New York, 29. If science in the past century has taught anything, it is that preventive is better than curative medicine. Within the past few years the cities mentioned vied with each other, prompted by science and philanthropy, in the building of hospitals for the sick and wounded. These hospitals were monuments to architectural taste and skill. Their libraries were filled with the medical lore of centuries. Their dispensaries contained every known article in the materia medica. The wards had every appliance that the mind could conceive or mechanical ingenuity contrive. Skilled surgeons and physicians were called from all great centres of learning, and students flocked from every country to see them operate and hear them lecture, with what result? The death-

rate for ordinary surgical operations was simply appalling. It distracted the minds, sickened the hearts, and palsied the hands of men with iron nerve. It was discovered that the Great Destroyer was in the air, the water, the furniture, the pin of the nurse, the finest suture, the surgeon's needle, his touch, "nay, there was no idle and unnoted thing" that did not carry disease. The microscopist found the cause, and its remedy—cleanliness and chlorine. I am of the opinion that the high death-rate of great cities is not a necessity. The remedy is in the home and the family. It is hard to believe that the "Giver of all Good," who orders all things in heaven and earth, ordained that men should dwell together in great cities, and not have the means to destroy their own filth. He gave sunshine, fresh air, fire and water, and chlorine—this is in the marine plants in the lowest depths of the great sea, and in the fumes which issue from Mount Vesuvius. It is in inland seas and lakes, in valleys and mountains, and every drop which makes the boundless ocean contains the elements of disinfection for cleanliness and chlorine. We have the intelligence to know, and should have the industry to apply.

E. Sum.

DISINFECTANTS AND THEIR USE.

No. 8.

By disinfectants we mean those substances used to neutralize or destroy noxious odors and gases, or whatever may produce infection. The term is sometimes used in a broader sense, and made to include agents that arrest decay of organic compounds by preventing the growth of those minute organisms which induce putrefaction and fermentation, and such agents are known as antiseptics.

In order to write intelligently on this subject, which is one of incalculable and vital importance at all times, and especially now, when we are threatened with that most dreaded of maladies, the Asiatic cholera, it is necessary to know the primary causes of infection and the action of the agents by which it is prevented.

The chief causes, either directly or indirectly, are the presence of foul gases and minute organisms or germs, both of which result from decay and putrefaction.

To these minute organisms, which are either animal or vegetable, and designated as bacteria, fungi, etc., are ascribed the causes of small pox, scarlet fever, cholera, and other contagious diseases.

Having ascertained the cause and nature of these enemies to human health and happiness, we must now consider the means by which we can best resist their attack, and destroy them.

As absolute purity of the atmosphere is the principal condition necessary to prevent contagion, the most practicable method of procedure is one which will prevent decay and putrefaction and also destroy the poisonous gases and disease germs which result therefrom. As before stated, the agents by which this is accomplished are called disinfectants, and their efficacy depends entirely on their power to render these poisons and organisms inert.

Nature has provided us with the most important agent, the oxygen of the air, but this does not suffice.

We are still dependent to a great extent on our own resources.

From what has been said, it will readily be seen that the first step in disinfecting is thorough ventilation.

As more or less offensive odors are constantly arising from sewers, sinks, water closets, etc., these should be frequently cleansed and disinfected. For this purpose a solution of copperas (about one lb. to a gallon of water) is to be recommended; or what is still better, a mixture prepared by dissolving 5 lb. of copperas and 12 oz. of crude carbolic acid in 5 pints of water.

It might be well to mention here that the disinfecting properties of carbolic acid were formerly much overrated. It has been abundantly proved that pure carbolic acid stands far down the list of disinfectants. The crude acid, however, possesses considerable virtue, and is by no means to be discarded from our list.

A solution of chloride of zinc has proved to be quite effective. It may be prepared as follows: take 2 pints of hydrochloric acid, and to it gradually add a sufficient quantity (about 1 lb.) of metallic zinc cut into small pieces, to neutralize the acid. Then filter, and add enough water to make one gallon. This of course makes a crude solution, but it is sufficiently pure for all practical disinfecting purposes. It should be used quite freely, care being taken not to let it come in contact with the skin, as it is a powerful caustic.

Another valuable agent is to be found in Labarraque's solution, or solution of chlorinated soda, which is made by triturating 11 oz. of chlorinated lime into a smooth paste with 3 pints of water. To this add 14 oz. of potassium carbonate dissolved in 3 pints of boiling water. When cold, add 3 pints of water, and after the sediment settles decant the clear solution.

The value and use of chlorinated lime are so generally known that it requires but little notice, but our remarks would be incomplete without giving it mention.

For disinfecting sewers, water closets, etc., there is probably nothing better, but it is not adapted for use in sick rooms and hospitals, as the chlorine evolved during its decomposition is decidedly disagreeable.

The same objection is equally applicable to Labarraque's solution.

A cheap and reliable disinfectant may be prepared from the following formula:

Nitrate of lead	2 oz.
Water	1 pint.
Dissolve.	
Chloride of sodium	8 oz.
Water	3 pints.
Dissolve.	

Mix the solutions, filter, and add 1 pint of the filtrate to 8 gallons of water.

This preparation, being odorless, is preferable to many others. Some of the disinfectants in common use, chlorinated lime for example, possess a more disagreeable odor than that of the gases they are intended to destroy. Therefore, it is advisable, especially in sick rooms, to use inodorous substances. For this purpose a solution of potassium permanganate (1 oz. to a pint of distilled water) has proved very efficacious—a small quantity being exposed in an open vessel in the room until it becomes decolorized.

All of the foregoing solutions, with the possible exception of the latter, are best used by pouring freely into the sinks, drains, or whatever place is to be disinfected. For use in sick chambers simply moisten cloths or sponges, and place about the room.

For cesspools, privy vaults, etc., alum, chloralum, freshly slaked lime, and chlorinated lime are inexpensive and effectual.

We will now consider the method and agents used in fumigating rooms, clothing, etc. In order to eradicate contagion, it is absolutely necessary to thoroughly fumigate the houses and contents in which infectious diseases have occurred, before they are again occupied.

One of the methods of fumigating rooms which has been in vogue for ages, and one which is exceedingly convenient and productive of good results, is by sulphur burning. The room should be unoccupied, and all colored fabrics removed, as the sulphurous acid gas produced its extremely suffocating, and is decidedly bleaching in is action. The sulphur is then ignited, and the room tightly closed. Not only noxious odors, but also the life of minute organisms, are destroyed. After remaining closed for several hours

the room should be opened and thoroughly ventilated, when it is again ready for occupancy.

For fumigating purposes there is nothing superior to chlorine. Although not quite so available as sulphurous acid gas, it is readily obtained by mixing together sodium chloride, black oxide of manganese, and sulphuric acid in proper proportions. The following quantities will evolve sufficient gas to thoroughly disinfect a room 12 or 15 ft. square:

Sodium chloride..............................	3 oz.
Black oxide of manganese..................	1½ "
Sulphuric acid,	
Water..	aa 2⅛ "

The superiority of chlorine in fumigating results from the readiness with which it produces chemical changes, and the properties of arresting decay and destroying disease germs. It is very poisonous and irritating, and the same precautions are to be observed as in the use of sulphur, chlorine being also an energetic bleaching agent. Thorough ventilation must of course follow its use.

Contagious diseases are frequently contracted from infected clothing, bedding, etc. It would therefore be folly to fumigate a room and then to return to it non-disinfected goods.

We know of no better method to purify articles of this kind than by hanging in chambers into which air, heated to a temperature ranging from 200° F. to 250° F., is forced. By this means the germs will be entirely destroyed, for neither animal nor vegetable life can long exist when exposed to so high a degree of heat.

Although it may be that no new facts have been presented in connection with this important subject, it is to be hoped that this article will be productive of some good.

DISINFECTANTS AND THEIR USE.

No. 9.

WHEN contagion exists, or is threatened, our first duty is to combat it by proper disinfection, and to remove the sick and infected at once to safe quarters, and no valuable time should be lost in doing this.

It would lead us too far from our theme to describe how the removal of the sick and the quarantining against them should be conducted. We will only draw attention that, in isolating and housing them, care should be exercised that no unnecessary blankets and bedding should be exposed to infection, and that attendants, before mingling again with the outer world, should themselves, as well as their clothing, be subjected to a thorough disinfection. They should be made to change the clothing they wear while in contact with the sick, and we recommend that their clothing be of easily washable stuff, made from cotton or linen. As contagion is due to minute micro-organisms, whose life and spreading produce new cases of disease, which, in turn, enlarge the danger of further and greater spreading, our aim to disinfect must, from the start, be directed in two different but allied ways

As the seed of a plant or the egg of an insect largely depends on outer influences for its healthy growth or its future development, so it is urged that the living disease germs need specific influences to develop their full virulence. Epidemic diseases generally need for their spread and development heat, moisture, and filth; and, while the sanitarian cannot combat the former, his efforts should be peremptorily directed against the latter and its consequence, foul atmosphere. It must, then, be our object, when we disinfect, to destroy the epidemic-producing micro-organisms, and to do away with everything which would be liable to aid in propagating those which we did not succeed in destroying.

It is a recognized fact that in the urine and fæces, in the sputa, and in the blood, the disease germs especially

abound, and we ought at once to disinfect these and everything they come in contact with. The clothing, bedding, etc., should, if possible, be burned, as the fire is the surest and swiftest remedy. If this is not done, we should wash the cloth in boiling water, with plenty of soap, using at least two or three ounces of good laundry or carbolic soap to each five gallons of soft water.

In disinfecting we should not lose sight of two important factors, *first*, that partial disinfecting is worse than none at all, as by it we are lulled into fancied security, from which awaking is so much more bitter, as we generally find how easily, with a little circumspection, we could have avoided danger. Under no circumstances should we stint the quantity of disinfectant employed; and while we do not advocate waste, the quantity should in all cases exceed the quantity absolutely needed, according to the calculations we have previously made, with regard to space and bulk of infected matter. *Secondly*, that the practice which is preferable to theory has taught us, beyond doubt, that no *special disinfectant* meets all cases, and that most of the extensively advertised so-called disinfectants, while often possessing decided antiseptic properties, answering in many cases, are, however, not to be relied upon as general disinfectants. It is therefore essential that the remedy should suit the case; for example, a half per mill of corrosive sublimate solution is a powerful and reliable germicide, answering well for covering the fæces and expectorations of infected sick and for the soaking of their soiled cloth. It does not answer as a disinfectant for sick rooms, sleeping apartments on board of vessels, or for houses as it is impossible to reach with it every space where contagion may lurk, and its highly poisonous properties make it a dangerous thing to handle by laymen. To properly disinfect the interior of these named places the floor should be sprinkled with a one per mill solution of corrosive sublimate, then scrubbed with hot water and soap, and properly fumigated while still damp from the scrubbing. The gaseous disinfectants are beyond doubt the most efficacious. Nothing can replace fumigation, nor can a substitute be found which is more penetrating.

The oldest disinfectant, in a gaseous form, known to us

is sulphurous acid, of which Ulysses of Ithaca availed himself when he purified the air in the castle where the bodies of his enemies lay. Modern discoveries in microzoic pathology have, however, led to an attack upon this powerful disinfectant. It is claimed that, while being instrumental in killing bacteria and micrococci, the spores are not attacked by it. (Dr. Wolffhugel)

The most reliable disinfectant is moist chlorine gas, or hypochlorous acid; and in disinfecting in the still moist rooms we should employ, for every cubic metre of space to be disinfected, one-half ounce of dry chloride of lime. We should mix it with water to a thick cream, and divide this mixture in several vessels, adding to each twice as much of crude muriatic acid as it contains lime. We should shut up the room tightly and leave it so at least two or three hours, and then it should be well aired.

Alleys, cellars, gutters, and yards should be freely sprinkled with unslaked, or still better chloride of lime, which cannot be surpassed by either carbolic acid, plaster of Paris, or any other disinfectant. Fumigating with tar is, on account of the cheapness of material, to be encouraged, but as a perfect germicide we cannot wholly rely upon it. This is a good antiseptic method, but an article might be an antiseptic and at the same time not a germicide, just as ferrous sulphate is a splendid deodorizer for privies and cesspools, but as the means of killing bacteria is inert. In our estimation, where chlorine fumigation can possibly be employed we should rely upon it as the surest and swiftest destroyer of bacteria, micrococci, and *spores*.

Bedding, mattresses, carpets, and woolen stuffs should either be sprinkled with a one per mill solution of corrosive sublimate, or should be wrapped in sheets dampened with such a solution, then the infected material should be exposed to a heat of not less than 240° Fahrenheit in apartments properly constructed for the purpose. In handling infected or suspected material, as little dust as possible should be raised. With rags, and especially woolen ones, the method for disinfecting should be especially severe, as these are looked upon as highly dangerous in spreading contagion. They should be disinfected by sprinkling with

corrosive sublimate solution, or a three per cent. solution of chloride of zinc, or a two per cent. solution of permanganate of potassa, or a combination of these solutions, and they should be aired, and thereafter exposed to dry heat of 240 Fah. for several hours. The corpses of persons having died of cholera, yellow fever, small-pox, or typhus should, when cremation is not performed, be wrapped before burial in sheets saturated with a strong solution of corrosive sublimate, and be covered with lime or, better, chloride of lime For the disinfection of closets and sinks this solution answers well, and needs for perfection only an addition of two per mill of corrosive sublimate, which last named of course has to be left out when the disinfectant is liable to come in contact with either zinc, lead, or copper, and then be substituted by permanganate of potash. We use for every estimated hundredweight of fæcal matter in vault or cesspool one pound of copperas and one ounce of corrosive sublimate in the proper solution, which should be distributed around the walls of the vaults as well as covering the deposit in them. In no case should we rely on commercial carbolic acid, but if carbolic acid is insisted upon, a 10 per cent. solution of pure or nearly pure acid should be the disinfectant.

For washing the body and clothes, where corrosive sublimate cannot be employed, a five per cent. solution of carbolic acid is indicated.

In diphtheria, in rooms where the sick remain, towels hung up and moistened with a solution of bromine, 1 drachm of bromine, 6 ounces of alcohol, and 4 ounces of water, answers admirably, and this solution is preferable to carbolic acid, which frequently proves obnoxious.

As decay or fermentation of animal matter endangers health, all household refuse should be put into the furnace, and cremated at once, or by the municipality, in properly constructed crematories, erected for this purpose. The carcasses of animals should be disposed of at once, and, if buried, should be covered with lime, and plentifully covered with nature's best disinfectant, *loam*.

Urinals, which frequently prove obnoxious, should be rinsed with a strong solution of chloride of lime, using 5 ounces of dry chloride of lime to 1 gallon of water, which is

somewhat in excess of that actually needed; but we prefer this, as some brands of chloride of lime prove more or less deficient in chlorine; still better is the freshly prepared U. S. P. solution of chlorinated soda.

Permanganate of potash solution, 2 or 3 drachms to the gallon, is often useful when carbolic acid or chloride of lime, on account of their obnoxious odor, are undesirable. For an antiseptic and disinfecting toilet preparation some good cologne, containing 40 grains eucalyptol, answers the purpose.

Many chemicals combine strong antiseptic, deodorizing, and germ killing qualities, but their cost forbids their liberal employment, as, for example, peroxide of hydrogen, chromic acid, etc.

In concluding, we wish to state that disinfectants in powder form, prepared by mixing corrosive sublimate with plaster of Paris, the mixture containing one-tenth of the latter, or carbolate of lime, or other carbolic powders, should only in exceptional cases be employed, as the old Latin proverb "*Corpora non agent nisi fluida sunt*" holds epecially good in regard to disinfectants.

Further, that in the time of epidemics the disinfecting is frequently repeated, and that we avail ourselves as much as possible of the disinfectants nature provides us with, fresh air, sunlight, and water for cleansing purposes, adding the disinfectant available to all—"soap." Bountiful quantities of hot water and good soap can do much toward stopping even cholera, yellow fever, and small-pox.

MULTUM IN PARVO.

DISINFECTANTS AND THEIR USE.

No. 10.

WHEN we dilute, cover with sufficient absorbent matter, burn up, or otherwise decompose infected matter until it becomes harmless, we disinfect.

My idea of diluting is exemplified by the Mississippi River, which is polluted by all kinds of dangerous matter, and still its water is drunk with impunity, and many people consider it healthier than most well or cistern water. In a great mass of water in motion, infected matter is soon diluted, and such a homœopathic dose does no perceptible harm

But I do not advocate throwing dangerous matter into the waters. The earthy matter suspended in the rivers, fish, and other things do their share of disinfecting, but we should not rest in idle imaginary security while we have the means for improvement at hand. The surest and cheapest disinfectant in the end is sufficient heat to decompose or burn up all infected or useless and dangerous material. The higher the heat, the surer the result.

A large fire, drawing its main supply of air from sewers, and carrying it through high chimneys, above the house tops, would make an excellent disinfecter, as this fire could by suitable construction be utilized to burn up infected and dangerous material, thus making a harmless and useful fertilizer out of the most dangerous material. It takes a wise man to tell when disinfection is complete without waste of material. For common people it is better to waste a little material than, by false economy, run the risk of becoming sick, or even leaving a feeling of doubt and uneasiness.

The next surest, and generally cheapest, disinfectants are : All kinds of coal, plaster of Paris, fresh burnt lime, copperas, and calcined and other earths; and their success is in proportion to their dryness, fineness, quantity, thoroughness of application, and the time allowed them to do their work before they are disturbed.

Whitewashing, and otherwise covering, washing with plenty of pure water, repeated boiling or drying, good ventilation and draining, kill many germs of disease or prevent them from doing harm.

An ordinary liberal disinfecter is often better than a scientific stingy one. In Brighton, Ill., years ago, I treated a case of cholera, contracted in St. Louis, Mo., during the last epidemic. All containers of excrements of the patient were buried immediately. The patient recovered, and cholera disappeared from Brighton. In Hecker, Ill., where no such precautions were used, many people died from cholera, and this finally disappeared by limitation.

Salt, preferably rock salt, is the safest disinfectant for internal use in diphtheria and scarlet fever which I have tried. It has the great advantage of doing no harm. It should be sucked frequently, and as much as can be borne with comfort.

Fowler's solution of arsenic is the best killer of germs which, if in sufficient quantity, produce sickness in man. I have used it with the best effect whenever suspicion pointed that way, and with a view to prevent Asiatic cholera, also hog and chicken cholera. It should only be used under advice of competent persons.

In conclusion, I wish to say that a handkerchief infected with diphtheria or scarlet fever, or a chamber vessel infected with cholera, is better disinfected by repeated boilings in plenty of pure water, and then thoroughly exposed to sun and air, than if dipped in the strongest preparation of any other disinfectant now generally used. If something must be used to satisfy our demand for a change of smell, or a scientific chemical disinfection, add all the carbolic acid you can without harm, or if that is objectionable, use the following, plentifully applied. This I have used for many years for disinfecting wounds, with universal satisfaction: Dissolve 3 drachms salicylic acid and 6 drachms granulated sulphite of soda in 1 quart pure water.

And, lastly, attend to everything upon which I have said that the success of disinfectants depends.

O. K. L. L.

DISINFECTANTS AND THEIR USE.

No. 11.

A PRACTICAL PRESENTATION OF THE RESULTS OF RECENT RESEARCH REGARDING THEIR COMPARATIVE VALUE, MODE OF PREPARATION, AND METHOD OF USE.

THE recognition of the necessity for disinfection as a means of preventing the development and propagation of disease is as old as is the history of infectious disease itself.

The appreciation, however, of what really constitutes adequate disinfection, the distinction between disinfectants, deodorizers, and antiseptics, and definite knowledge as to the actual disinfecting power of agents conveniently massed under the term disinfectants, may be said to date from the discoveries incident to the researches of the past three or four years, and more especially from the recent experiments of the Committee on Disinfectants of the American Public Health Association, whose published preliminary reports have done much to dispel popular illusion on this subject, and exhibit clearly the comparative utility or worthlessness of agents of this class.

DEFINITION OF DISINFECTANT.

Much confusion exists in the popular mind, and not a little in the minds of physicians and even sanitarians, as to the meaning of the term disinfectant.

The committee alluded to above define a disinfectant to be *an agent capable of destroying the infective power of infectious material.* Thus the term disinfectant signifies a germicide, or germ killer.

It has been proved for several kinds of infectious material that its specific infecting power is due to the presence of living micro-organisms known in a general way as disease germs, and practical sanitation is now based upon the belief that the infecting agents in all kinds of infectious material are of this nature. Disinfection, therefore, consists essentially in the destruction of disease germs.

Popularly, the destruction of bad odors or the arrest of

putrefaction is wrongly supposed to constitute disinfection, and any agent which neutralizes or disguises the odors arising from putrefying material is regarded as a disinfectant.

In reality, however, agents which simply mask unpleasant odors should properly be called deodorizers, and, while they serve an admirable purpose, this purpose is not the destruction of disease germs.

So, also, agents which have the power to arrest the process of putrefaction, although their value in the economy of health and the prevention of disease is unquestioned, are properly termed antiseptics, and should not be confounded with disinfectants proper.

Recent researches have demonstrated that many of the agents which have been found useful as deodorants or antiseptics are entirely without value for the destruction of disease germs. It is apparent, therefore, that injurious consequences might easily result from confusing these terms.

The following table, from Miquel, which we take from the *Weekly Medical Review*, for January, 1885, shows the apparent value of many disinfectants, so-called, but does not exhibit their real utility for popular use, since this must be determined, not alone by the activity of the agent, but also by its cost and range of applicability. The figures give the amount of the compound which was required to preserve 1,000 c. c. of beef-tea.

	Grms.
Mercuric iodide	0·025
Silver iodide	0·03
Hydrogen peroxide	0·05
Mercuric chloride	0·07
Silver nitrate	0·03
Osmic acid	0·15
Chromic acid	0·20
Iodine	0·25
Chlorine	0·25
Hydrocyanic acid	0·40
Bromine	0·60
Chloroform	0·80
Copper sulphate	0·90
Salicylic acid	1·00
Benzoic acid	1·10

	Grms.
Potas. chromate	1·30
Picric acid	1·30
Lead chloride	2·10
Mineral acids	2·00-3·00
Essence bitter almonds	3·20
Phenol	3·20
Potas. permanganate	3·50
Anilin	4·00
Alum	4·50
Tannin	4·80
Arsenious acid	6·00
Boracic acid	7·50
Chloral hydrate	9·00
Ferrous sulphate	11·00
Amyl alcohol	14·00
Ethyl sulphide	22·00
Borax	70·00
Ethyl alcohol	95·00
Potas. sulphocyanide	120·00
Potas. iodide	140·00
Potas. cyanide	185·00
Sodium hyposulphite	275·00

In testing the various commercial disinfectants, Dr. Duggan, working with Dr. Sternberg, using broken-down beef-tea containing spores of Bacillus subtilis and Bacillus anthracis, obtained the following interesting table of results:

	Per cent. in which active.	Per cent. in which failed.
Little's soluble phenyl	2	1
Labarraque's solution	7	5
Liquor zinci chloridi (Squibb's)	10	7
Feuchtwanger's disinfectant	10	8
Phenol sodique	15	10
Platt's chlorides	20	15
Girondin disinfectant	25	15
Williamson's sanitary fluid	25	20
Bromo-chloralum	25	20
Blackman's disinfectant	30	20
Squibb's solution of impure carbolic acid (about two per cent.)	..	50
Burchardt's disinfectant	..	50
Listerine	..	50

Apropos of the relative value of these agents, Dr. Sternberg very pertinently remarks that the relative value of the agents as here given does not establish their comparative practical value as disinfectants, since questions of cost, physical and chemical properties, etc., must also be taken into consideration.

The disinfectants which we believe, from a careful study of the literature on the subject, and from interviews with many sanitary officials who have given especial attention to this subj ect, to best meet the indications presented, are the following, namely :

LIST OF DISINFECTANTS RECOMMENDED, AND THEIR METHOD OF PREPARATION.

No. 1. Chloride of lime of the best quality (containing at least twenty-five per cent. of available chlorine), dissolved in soft water in the proportion of 4 ounces to the gallon.

No. 2. Corrosive sublimate and permanganate of potash, dissolved in soft water in the proportion of 2 drachms of each salt to a gallon.

No. 3. Labarraque's solution (liquor sodæ chlorinatæ, U. S. P.), dissolved in soft water, one part of the officinal solution to five parts of water.

No. 4. A powder consisting of one pound of chloride of lime, one ounce of corrosive sublimate, and nine pounds of plaster of Paris. To prepare for use, pulverize the corrosive sublimate, and mix thoroughly with the plaster of Paris, then add the chloride of lime, and mix well; pack in pasteboard boxes or in wooden casks.

No. 5. Corrosive sublimate dissolved in water (solution is greatly facilitated by heat), in the proportion of four ounces to the gallon, and one drachm of permanganate of potash added to each gallon, to give color to the solution.

No. 6. Sulphurous acid gas produced by the combustion of sulphur.

No. 7. Dry heat.

No. 8. Moist heat.

These preparations are identical with those determined by the Committee on Disinfectants of the American Public Health Association to be the best.

According to the deductions drawn from the latest scientific research and experiments, they embrace every agent essential to the thorough disinfection of the person, the clothing, the ingesta, the excreta, the sick room and its contents, furniture, bedding, etc., the drain, the sink, the vault, the house and its surroundings, and may be employed as well, on a larger scale, for the disinfection of ships or of cities—in short, wherever disinfectants may be indicated.

DIRECTIONS FOR THE USE OF THE DISINFECTANTS RECOMMENDED.

Before explaining in detail the mode of using the disinfectants recommended so as to secure the best results from their use, we will briefly state in general terms the kinds of material which are most often the medium of conveying infection, and which practically form, therefore, the substances to the disinfection of which the efforts of the sanitarian must be addressed. They are chiefly the following, namely:

The ingesta (food, drink, etc.).

The excreta (fæces, urine), also vomited and expectorated matter, and the receptacles of such material (which would include the vessels, vault, water closet, etc., into which it was deposited).

The persons of the sick and their attendants.

Infected clothing, bedding, carpets, furniture, etc.

The floors, walls, ceilings, woodwork, etc., of an infected room or house.

Accumulations of organic material, either infectious in itself or which may serve as a nidus for the development of disease germs.

The question of disinfection resolves itself, then, into a detailed consideration of the best method of applying disinfectants to material of this character so as to render its infectious power permanently inoperative.

THE DISINFECTION OF INGESTA (FOOD, DRINK, ETC.).

A number of infectious diseases, notably cholera and typhoid fever, frequently gain access to the system through infected water, milk, and articles of food.

The infecting power of such ingesta may be destroyed

by the simple expedient of boiling, since a temperature of 212 degrees Fahr. maintained for half an hour will kill all known varieties of disease germs.

It is probable indeed that the germs of diphtheria, cholera, and yellow fever are destroyed by a much lower temperature than that of the boiling point.

During the prevalence of an epidemic of cholera, it is well to boil all water for drinking purposes. After boiling, the water may be filtered, if necessary, to remove sediment, and then cooled with pure ice.

An ordinary sheet of filtering paper, like that used by druggists, and a glass, are all that are necessary to filter water on a small scale for drinking purposes. The paper should be changed daily.

THE DISINFECTION OF EXCRETA AND OF VOMITED AND EXPECTORATED MATERIAL.

The fæcal discharges in infectious diseases may be disinfected by thoroughly mixing with each discharge a pint of the solution of chloride of lime, which we have described as disinfectant No. 1. The discharges should not be emptied into the vault or water closet for at least ten minutes after adding the solution.

Urine and vomited and expectorated matter may be disinfected the same way. They should be, preferably, received into vessels containing the disinfectant solution. The cost of the solution is about two cents a gallon.

An objection to the use of the chloride of lime solution exists in its disagreeable odor; should this be an obstacle to its use, the solution of corrosive sublimate and permanganate of potash, described as disinfectant No. 2, may be used in precisely the same manner, except that it should remain in contact with the infectious material an hour or longer. (It may also be worthy of note here, that disinfectant No. 2 will damage lead pipes, if passed through them in considerable quantity.) The cost of this solution is also about two cents a gallon.

The excreta and vomited and expectorated matter may also be disinfected by Labarraque's solution, diluted, described as disinfectant No. 3. This may be used in the same way and in about the same quantity as disinfectant solutions Nos. 1 and 2. Its cost, however, is greater, being about nine cents a gallon.

An excellent disinfectant or antiseptic powder is that described as disinfectant No. 4, consisting of corrosive sublimate, chloride of lime, and plaster of Paris. A thin layer of the powder should be added to excreta and other material to be disinfected, and if such material be not already liquid, sufficient water should be poured over it to cover it.

DISINFECTION OF THE PERSON.

Labarraque's solution diluted, described as disinfectant No. 3, should be used to wash away infectious discharges from the surface of the body of the sick or their attendants.

When the infectious agent is given off from the entire surface of the body, as in scarlet fever, small-pox, etc., the body should be occasionally sponged with Labarraque's solution, diluted with twenty parts of water.

The surface of the bodies of patients dying from an infectious disease should be washed with one of the solutions described, and then enveloped in a sheet saturated with the same.

DISINFECTION OF CLOTHING, BEDDING, ETC.

Soiled clothing from the person or bed of the sick should, on removal, be immersed in boiling water, and put through the ordinary operations of the laundry, or it may first be soaked for several hours in a solution containing one fluid ounce of the solution of corrosive sublimate, described as disinfectant No. 5. If this solution be used, the clothing to be disinfected should be placed in a wooden tub, and not a metal receptacle, as the latter would precipitate the mercury.

Instead of disinfectant solution No. 5, disinfectant solution No. 1 may be employed, diluted with nine parts of water.

Clothing and bedding which cannot be washed may be disinfected by exposure to dry heat, in a properly constructed disinfecting chamber, for three or four hours. A temperature of 230 degrees F. should be maintained during this time, and the clothing must be freely exposed, for the penetrating power of dry heat is very slight. This temperature will not destroy the spores of bacilli, but is effective for the destruction of all disease germs which do not form spores, and there is good reason to believe that

this list includes small-pox, cholera, yellow fever, diphtheria, erysipelas, puerperal fever, and scarlet fever. Moist heat is far more effective.

DISINFECTION OF AN INFECTED ROOM OR HOUSE.

When an apartment which has been occupied by a person sick with an infectious disease is vacated, it should be disinfected. The object of disinfection in the sick room is mainly the destruction of infectious material attached to surfaces or deposited, as dust upon window ledges, in crevices, etc.

All surfaces should be thoroughly washed with a solution of corrosive sublimate of the strength of one part in a thousand parts of water, which may be conveniently made by adding four ounces of disinfectant solution No. 5 to the gallon, or one pint to four gallons, of water. The walls and ceiling, if plastered, should be whitewashed with a lime wash containing the same proportion of corrosive sublimate, or they may be brushed over with the aqueous solution. Especial care must be taken to wash away all dust from window ledges and other places where it may have settled, and to cleanse thoroughly crevices and out of the way places.

Many sanitary authorities consider it necessary to insist upon fumigation with sulphurous acid gas. Exposure to this agent, in sufficient quantity, and for a considerable time, especially in the presence of moisture, is destructive of disease germs in the absence of spores.

To secure any results of value it will be necessary to close the apartment to be disinfected as completely as possible by stopping all apertures through which the gas might escape, and to burn not less than three pounds of sulphur for each thousand cubic feet of air space in the room.

To secure complete combustion of the sulphur it should be placed in powder or in small fragments in a shallow iron pan, which should be set upon a couple of bricks in a tub partly filled with water to guard against fire. The sulphur should be thoroughly moistened in alcohol before igniting it.

DISINFECTION OF PRIVIES, CESSPOOLS, ETC.

Disinfection of privies and cesspools may be ac-

complished either with corrosive sublimate or with chloride of lime. The amount used must be proportioned to the amount of material to be disinfected. One pound of corrosive sublimate should be used for every five hundred pounds of fæcal matter contained in the vault, or one pound of chloride of lime to every thirty pounds of fæcal matter.

Disinfectant solution No. 5, diluted with three parts of water, may be used, or disinfectant solution No. 1 will also be equally efficacious. All exposed portions of the vault and the woodwork should be thoroughly washed down with the disinfectant solution.

DISINFECTION OF ACCUMULATIONS OF ORGANIC PUTREFYING MATERIAL.

If accumulations of this kind cannot be totally destroyed, they should be removed as far as possible from human habitation, and treated with antiseptics and disinfectants. For this purpose the disinfectant solution No. 1 or the antiseptic and disinfectant powder described as disinfectant No. 4 may be used with advantage.

In conclusion, we may say that while the disinfectants described do not, apparently, offer a very large margin of profit to the drug trade, it is believed that the education of the masses up to a proper appreciation of the necessity for their extensive use will create a demand which will so increase the volume of business in this class of products as to more than compensate for the lower profit obtained from their sale, as compared with that of many disinfectant compounds now on the market, whose cost precludes their general use, and many of which have been proved, in reality, utterly valueless as disinfectants. No amount of disinfection will supply the place of cleanliness and fresh air, but lack of the one and absence of the other make disinfectants a *sine qua non* to the maintenance of health and the prevention of disease.

Much remains to be done in the direction of placing disinfectant agents on the market in a convenient form for popular use. To do this will naturally be the province of the pharmacist, and it is hoped, in the interests of public health and in the interests of the drug trade, preventive medicine will occupy at no distant day its true position,

and that there may be fewer drugs and more disinfectants sold.

The author begs to acknowledge his indebtedness for the views advanced in his essay to the published writings and the informal statements of many eminent sanitary authorities, among whom may be mentioned the Committee on Disinfectants of the American Public Health Association; Prof. Geo. H. Rohe, M.D., Professor of Hygiene in the College of Physicians and Surgeons, Baltimore; Geo. M. Sternberg, M.D., Surgeon, U. S. A.; Prof. Chas. F. Chandler, M.D., Professor of Chemistry in Columbia College, and College of Physicians and Surgeons, New York City; Prof. Victor C. Vaughan, M.D., Professor of Chemistry in the University of Michigan; Prof. A. R. Leeds, M.D., Professor of Chemistry in Stevens Institute of Technology, Hoboken; and others, whose recent labors have contributed to the elucidation of the subject.

NULLA DIES SINE LINEA.

DISINFECTANTS AND THEIR USE.

No. 12.

FROM a chemical point of view, it is conceded that no absolute line of demarkation can be drawn between the intimately related processes of *fermentation* and *putrefaction*, and it is, furthermore, very generally conceded that these processes are correlative of the growth and multiplication of living organisms of the lowest known forms. These organisms are known as vibrios, microzymes, or bacteria, and they are as uniformly coexistent with diseases as they are with fermentation and putrefaction.

The question as to the precise significance of this coexistence in either case presses for solution. Are these minute organisms the initiators of these chemical processes, and are they the sole causes or inciters of those morbid processes with which they are known to coexist? The weight of scientific evidence certainly seems to favor an affirmative answer to these questions. These micro-organisms produce their specific effects by the organic reproduction of their kind in the tissues or blood. The groups of symptoms and tissue changes which constitute the phenomena of infectious diseases are caused by the presence of countless numbers of the progeny of the micro-organisms originally introduced within the body.

These facts have given to the class of agents known as disinfectants a value which is not possessed by those of any other class The agents of this group have the power to destroy all animal or vegetable organisms with which they come in contact, and to arrest or prevent the process of putrefaction or zymosis, which they very probably initiate.

In the very front rank of disinfectants must be mentioned *sulphurous acid ;* it has a great affinity for oxygen, and by the abstraction of this element from organic matter, attacks it with great energy. It is very destructive to micro-organisms of every form, and is not appreciably affected in its action by any known conditions of the

media in which such organisms are found. Sulphurous acid gas is non-inhalable, as its powerful reducing action quickly coagulates the blood, abstracting its oxygen and turning it brown. It is also an irritant, causing a reflex spasm of the glottis, when inhaled in considerable quantity.

The potential quantities of sulphurous acid may be better understood by reciting the fact that a solution of one part in 666 parts of water will effectually destroy the germinating power of any known organism. Its action in this respect is about sixteen times as powerful as that of carbolic acid. Since it may be used either in the gaseous form or in solution in water, its range of usefulness is greater than that of any other disinfectant.

Greater permanency of action may be obtained, when a liquid disinfectant is required, by adding to a saturated solution of sulphurous acid about 3 per cent. of boric acid. This may be freely applied to the skin of human beings, or upon abraded surfaces, as it is entirely void of irritating properties; furniture and floors washed with it may be relied upon as being thoroughly disinfected. The cost of preparing this disinfecting solution is sufficiently low to permit of its use for general purposes of house disinfection. It is only necessary to bear in mind the fact that in disinfecting drains or water closets enough should be used to throughly deoxidize every particle of active organic matter.

Where circumstances will permit, the sulphurous acid gas should be used ; this is readily accomplished by burning sulphur in the apartment to be disinfected.

By way of caution, it should be observed that sulphurous acid in any form is a powerful bleaching agent, and as such destroys vegetable colors.

Numerous preparations containing carbolic acid or various combinations of chlorides are being strongly urged as disinfectants. While these may be entitled to some confidence, so far as their action upon the processes of fermentation and putrefaction is concerned, they are not *anti-zymotics*, and are void of action upon the infectious matters or organisms which incite those diseases known to be infectious.

A so-called disinfectant which does not possess the power

to destroy specific infectious matter is certainly not entitled to public confidence.

It is not the intention of the writer to detract from the generally recognized value of active oxygen, or ozone, or of chlorine gas, as potential disinfectants.

Each of those agents may have a distinct value, but there can be no valid reason for using any other than the very best and most potential agent in carrying out measures for the arrest or prevention of zymotic diseases, which are dangerous to human life. Feeling that he would do violence to his convictions upon the subject of practical disinfection in extending this inquiry to less potential disinfecting agents, the writer here rests his case, conscious of having performed a substantial service in citing the facts which he has garnered from an extensive personal experience with innumerable combinations of disinfecting agents.

SO_2.

DISINFECTANTS AND THEIR USE.

No. 13.

ALL organisms are built of various chemical elements, which under certain favorable conditions are endowed with life, and when brought under other conditions than those which favored their evolution, all exhibit a tendency to decompose, and, if the conditions are favorable, to be resolved again into their original elements. This decomposition or decay, to which all animal and vegetable matter is susceptible, is simply a rearrangement of the molecules, or a condition of *atomic activity;* the resulting compounds ultimately return to their elementary condition, or are finally converted into various oxides, in either case becoming perfectly innocuous.

However harmless the ultimate products of this atomic activity may be, human experience teaches that the intermediate products in the different stages of the putrefactive process are baneful. If the organism contains nitrogen, and the proper conditions of temperature and moisture prevail, putrefaction, with the evolution of offensive odors, quickly follows the cessation of vital energy. These offensive odors belong to certain gases or "intermediate organic compounds," which are finally destroyed by the completion of the process, or by oxidation. In almost every stage of the process of decomposition, certain compounds are evolved which may become the food of new organisms, either animal or vegetable. The natural process is arrested or modified only so far as the particular compounds used by these new organisms are concerned.

The process, however, goes on in a more or less modified form until the ultimate products are reached; these are "the original dust" and a few gases. Man has little to fear from the presence of these ultimate products of decomposition; it is the products evolved in the intermediate stages of the process which concern him from a sanitary point of view. Man has garnered the fact of the noxious

character of these gases out of a long line of human experience with plague and pestilence, while the process through which they affect him has defied his powers of observation and research.

Carbonic acid, ammonia, sulphuretted hydrogen, nitrogen, marsh gas, etc., are known to be harmful to health if present in the air in considerable quantities, but none of these gases (excepting possibly sulphuretted hydrogen) can be shown to occur in our dwellings in sufficient quantities to satisfactorily account for the occurrence of those diseases which are commonly associated with filth gases. Concerning sulphuretted hydrogen, we know that it is poisonous, but its unhealthiness as an ingredient of our atmosphere cannot be affirmed as a fact I do not wish to oppose the conjecture that in certain cases it does produce sickness, but I do wish to record my conviction that its pernicious influences are much overrated.

The fact is that all of the gases known to chemistry as products of decomposition are frequently generated in the laboratory, and persons there subjected to their influences do not suffer from any of the effects commonly ascribed to sewer gas or filth gases, which are popularly looked upon as the causes of the zymotic diseases.

This forces upon us the consideration of that mooted subject, the bacterial or germ theory of zymotic diseases. We know that the addition of a zymotic poison to sewer gas or filth gases at once induces an outbreak of the particular zymotic disease whose germs are present. Diphtheria, typhoid fever, malaria, cholera, yellow fever, and diseases of that class are each caused by the active agency of a specific poison, or *zyme*, which is now generally conceded to be *bacterial*.

Just what conditions are necessary to the production of a specific *zyme*, or whether the *zymes* familiar to us by their effects are really produced accidentally by ordinary decomposition, may not, in the present condition of our knowledge, be positively affirmed.

All of the zymotic diseases now known to us have been known for ages; we know that they originated somewhere under certain requisite conditions, but we have no evidence that any of the specific *zymes* can originate spontaneously under ordinary conditions of putrefaction

or decay. It is certain, however, that putrescent matter offers all of the conditions requisite to the rapid development of bacteria, and it therefore seems obvious that such matter constitutes a favorable base for the development of *specific zymes*, and the consequent spread of the class of infectious diseases.

The specific causes of these diseases are not distinguishable by the eye, but decaying matter is revealed to us by the presence of offensive odors. The offensiveness of such odors is no index of their dangerous character, and yet man has learned, by bitter experience, to associate the stench with the poison. Out of this association has grown the popular use of deodorizers and antiseptics, or disinfectants. Strictly speaking, these terms have a different significance, and it is unfortunate that in the popular use of the term "deodorizer" it has been accepted as an equivalent for antiseptic or disinfectant. The removal or abatement of offensive odors does not imply disinfection, and there can be no safety in anything short of that antiseptic action which arrests or prevents atomic or molecular change in matter, as well as the utter destruction of all germs of low forms of animal and vegetable life.

The term disinfectant applies solely to those agents which destroy the contagia or *specific zymes* of a disease, thereby depriving it of its infectious qualities.

The agents which accomplish this disinfectant action unite chemically with organic substances to form stable compounds, and thus reduce the atomic activity of the particles to a static condition. The manner in which disinfectants act is very various. Thus, permanganate of potash, ozone, and oxygen oxidize organic matter very rapidly. The action of chlorine is similar, as it becomes active through its power of abstracting hydrogen, and thus liberating the oxygen of water. Sulphurous acid exerts a reducing action upon organic matter by withdrawing oxygen, or, like chlorine, it may combine with hydrogen and remove it, or form substitution compounds. Chloride of zinc and some other metallic salts are active chiefly through their power of coagulating albumen or combining with it to form albuminates. Carbolic acid owes its activity to its power of arresting molecular change.

The nature of the medium in which the infectious matters or particles are suspended must determine the selection of a disinfectant. Infectious matter is apt to exist in aggregations or clouds, in air, water, or milk, being very rarely equally distributed throughout. It is furthermore particulate, or non-gaseous, in form, and if floating in the atmosphere would be unaffected by any solid or liquid disinfectant, which could not possibly come into intimate contact with every portion of the air. These facts constitute barriers to the practical use of disinfectants which, in the present state of our knowledge, we are powerless to overcome.

Infected air can only be purified by gaseous disinfectants, such as sulphurous acid or chlorine, which to be effective must be present in such quantities as to be incompatible with human existence. The proper use of disinfectants of this class must be limited to the disinfection of apartments or buildings which are not at the time occupied, and it is obvious that volatile disinfectants constitute the only reliable means of disinfecting inaccessible places. To accomplish the purpose, enough sulphurous acid or chlorine should be liberated to thoroughly saturate the atmosphere and ensure the penetration of any albuminous particles which may envelop virulent matter. Sulphurous acid gas, liberated by burning any convenient quantity of sulphur or brimstone, is probably to be preferred to chlorine, which is obtained by gently heating four parts of hydrochloric acid with one of binoxide of manganese, or by the action of dilute acids upon the various chlorides.

The presence of albumen is found to protect septic germs to a considerable extent against the action of chlorine, but has little or no influence upon the action of sulphurous acid or carbolic acid. The writer has a decided preference for carbolic acid where a steady disinfectant action is to be maintained for some time in occupied apartments.

In the management of cases of scarlet fever, small-pox, etc., it is probably superior to all other antiseptics or disinfectants, and to meet the requirements of such cases it should not only be applied to the skin (1 part to 20 parts of oil or lard), but the atmosphere of the apartment should

be kept at a point of saturation with the acid. This may be accomplished by evaporation from towels steeped in a solution of the acid and then hung up upon frames. Persons may live in an atmosphere thus saturated with carbolic acid, and experience no unpleasant effects. Under no circumstance, however, should carbolic acid be relied upon when the more po'ential agents sulphurous acid or chlorine are admissable.

For general purposes of disinfection, under the varying circumstances which are imposed by location, differences in media, character of infectious matter, and other collateral influences, reliance cannot be placed upon any single agent or combination of agents.

A few remarks concerning the best modes of carrying out practical disinfection under circumstances which commonly prevail may very appropriately conclude this paper.

Clothing, bedding, and articles which would not be injured thereby should be subjected to a temperature of 220° Fahr. for a period of at least two hours.

Clothing intended to be washed should be first steeped in a 5 per cent. carbolic solution or in a solution of the chlorides of soda, lime, magnesia, manganese, aluminium, etc. As soon as the sick room becomes unoccupied, it should be thoroughly cleansed. The walls and ceiling should be brushed, the floor should be washed with soap and water containing 5 per cent. of carbolic acid; the furniture should be similarly treated. All textile fabrics, as curtains, carpets, etc., should be subjected to heat. The chimneys, doors, windows, and all crevices should next be closed, and sulphur should be burned under the following conditions: A tub of water should be placed upon the floor; over this should be placed a quantity of sulphur (about 2 lb. for every 1,000 cubic feet of space) in an earthenware receptacle. The apartment should be kept closed for twenty-four hours, after which it should be thoroughly ventilated.

The excreta from cases of infectious diseases should be covered with a solution of the chlorides or of hydrochloric or sulphuric acid. Water closets or house drains should not be made the receptacles for such excreta until they have been thoroughly acted upon by the disinfectant.

Sewers, drains, and water closets, if properly ventilated, give rise to no gaseous emanations. In this manner, the noxious gases of decay may be so diluted as to prevent the development of disease germs, since, in common with all organisms, these germs require a certain degree of concentration in the substances supplied to them as food.

Where thorough ventilation cannot be secured, chlorides, or sulphate of iron, or carbolic acid are fair palliatives.

A one per cent. solution of chloride of zinc is worthy of special commendation in this connection. Special stress should be placed upon the importance of using a reliable amount of disinfectant.

The various disinfecting nostrums, which are urged with sweeping claims upon the part of their inventors, have, as a rule, little or no effect upon the *specific zymes* which we seek to destroy by the employment of disinfectants, although they may not be without value in arresting or preventing decomposition.

Elaborate chemical combinations of the different antiseptics, which will not stand the crucial test of destroying all forms of minute organisms or germs, have no claim to recognition in an article pertaining to practical disinfection.

COMMON SENSE.

DISINFECTANTS AND THEIR USE.

No. 14.

TIME and space not permitting to go into this subject in detail, I will, as briefly as possible, give my views upon what I consider to be the best modes of disinfec ing.

The best disinfectants with which we are at present acquainted are undoubtedly sulphurous acid, chlorine, bromine, mercuric chloride, carbon disulphide, and, most important of all, heat.

Sulphurous acid may easily be applied for the disinfection of rooms, etc., by burning sulphur in a sheet iron dish, or, as has been suggested, by burning carbon disulphide in a lamp.

Chlorine is most readily obtained by the spontaneous liberation from bleaching powder or solution of sodium hypochlorite, or by the action of sulphuric acid upon a mixture of binoxide of manganese and common salt. Chlorine as well as sulphurous acid should be generated in large quantities.

Bromine may be placed in an open dish and allowed to evaporate, or it may be used in a form recently patented in Germany, which consists of a block of porous material, preferably made of infusorial earth saturated with bromine. In the latter case the bromine can be handled with greater ease, and the vapor is given off more slowly and uniformly, thus producing better results.

Mercuric chloride has been used in the form of vapor by Prof. Koenig, of Goettingen, and in a paper recently published in the "Centralblatt fuer Chirurgie," he claims that he has thus used it with uniformly satisfactory results during the past twenty years, both in hospitals and in private sick rooms. Dr. Koenig's method of proceeding is as follows: The windows of the room are tightly closed, and an open coal furnace is placed in the room. Upon the fire is placed a coal spoon into which fifty to sixty grammes of mercuric chloride have been put. The person perform-

ing the operation quickly leaves the room and closes the door tightly, to prevent the otherwise too ready escape of the vapor. At the end of three to four hours the door is opened, as are also the windows, the mouth and nose of the person entering being covered with a cloth, to avoid inhalation of the poisonous fumes. After airing the room for some time, the windows are again closed, and the mercury which may remain is rendered harmless by the evaporation of sulphur. In the paper referred to, Dr. Koenig states that no injurious effects were ever observed, either in the persons concerned in the disinfection or the occupants of the rooms.

Carbon disulphide, which has been recommended by Pasteur, and more recently by Ckiandi Bey and others, may be used in the manner described under bromine ; or cloth saturated with it may be suspended in the rooms.

So much for the disinfection of rooms. To disinfect clothing, etc , the best process is to subject it to heat, a temperature of about 100° C. being sufficient to effect the purpose.

For privies, cesspools, sinks, etc., a solution of mercuric chloride will probably give the best results, a solution containing 2 per cent. of the salt being generally used. Good results are also obtained with zinc chloride, potassium permanganate, and ferrous sulphate ; but the mercuric salt is to be preferred. Carbon disulphide, bleaching powder, sodium hypochlorite, and bromine may also be used.

I would also suggest to druggists that a simple way of putting up disinfectants for use in water closets, etc., wherever applicable, consists in filling gelatin capsules with the dry salts. A gelatin capsule containing 20 grms. of mercuric chloride, for example, would be equivalent to a quart of a 2 per cent. solution. There would in this case be also less danger in handling the material, and a considerable saving in bulk. Carbon disulphide could also be put up in gelatin capsules. The capsules, which dissolve rapidly, will liberate the carbon disulphide, and its vapors will fill the air contained in the pipes, etc., thus disinfecting not only the liquid matter running through them, but also the air contained in them, which is of equal importance.

In conclusion, it may not be amiss to quote from Pettenkofer's review of Dr. Cunningham's "Report on Cholera in India." He says: "Cunningham plainly states, and gives evidence, that quarantines, inspections, cordons, isolation of cholera patients, disinfection of their stools, etc., have proved themselves as useless against cholera as a mounted guard would be to stop the monsoons."

BREVITAS.

DISINFECTANTS AND THEIR USE.

No. 15.

INFECTION.

BEFORE attempting the treatment of the subject of disinfection it seems, if not imperatively necessary, at least advisable, that it should be preceded by a brief resumé of our knowledge of infection and the theories relating to that subject.

The writer must beg your indulgence to that extent, and offers no other apology than that the better we understand the premises the better are we able to draw our conclusions regarding the main object of our paper, disinfection. While it is, of course, beyond the limit of this essay to discuss the many theories that have been advanced by scientists, it is, nevertheless, incumbent upon us to have such knowledge as will enable us to reason intelligibly in the application of disinfectants.

That infection is carried from diseased to healthy is self-apparent. But, we ask, how is it carried? Is this infectious matter a gas, a liquid, a vapor, or a solid, living or dead, organic or organized, animal or vegetable, a poison, a virus, or a ferment? If it were merely a gas, it would, by the laws of the diffusibility of gases, instantly expand on coming in contact with the air, and become so infinitely divided as to cease to have any influence; and, as Smith says: "If * it were a vapor, such as water, or any of the acids or fats which pass off along with the gases, the same infinite attenuation would take place when mixed with the air, and this extremely fine division would, so far as we know, entirely prevent any action." Again, all organic action is definite, and limited, by chemical action, to itself. It is the action of organic molecules, each possessing a definite saturating power, which, when once satisfied, their action is neutralized.

* See "Disinfectants," by Robert Angus Smith.

The relation between decomposition and disease was early recognized. The early chemists, looking at putrefaction from a chemical point of view, thought that animal and vegetable substances were capable of oxidizing or undergoing a change, *per se*, to decompose and give off noxious gases or effluvia which were capable of causing disease.

Such effluvia or offensive gases may certainly lower the tone, or the general condition, of the system, and, consequently, its power of resisting attacks on its vitality, but they cannot cause infectious disease.

In 1673, in that period that marked the transition from alchemy to chemistry, we find Boyle studying effluvia, and ten years later the Dutch microscopist Leeuwenhoek announcing the discovery of micro-organisms. The close chemical relation between putrefaction and fermentation was also early recognized, the difference being not in process but in product.

Berzelius tried to explain the action of fermentation and putrefaction by a theory of a new force, which theory was about as tangible as the old caloric theory. Liebig taught that the ferments were organic, but not organized, nitrogenous substances in a state of alteration consequent upon the action of catalytic oxygen. His theory was that fermentation was communicated by molecular movement, or contact of the ferment cell with the organic matter, thereby destroying the existing equilibrium of that body. We see in this theory of Liebig the view of a chemist to whom infection is merely a process of chemical action, transferred from one body to another. This theory was generally accepted till Pasteur began his classic investigations on fermentation. The vegetable origin of yeast was fully established many years before Pasteur's time, but it remained for him to discover that its fermenting action was due to a distinct microbion.

While admitting the action of ferments, he demonstrated that fermentation was necessarily associated with the presence of living micro-organisms, and that the so-called ferments are merely food for these microbes or germs. From his experiments, we must admit that fermentation and putrefaction, and necessarily infection, are the result of that unknown force which we call vitality, a process, not of death and decay, but of life, and, with Bechamp,

must we say: "Nothing is the prey of death; all is the prey of life." The germ theory of disease, first stated by Kircher, can be said to have had its origin in the discovery of Leeuwenhoek. While there have been many illustrious names connected with this field of scientific investigation, the persistent experiments and research of Pasteur remain, like himself, the central figure, the very foundation on which has been reared the modern germ theory.* While this theory of organized germs is not entirely accepted, the proof is becoming so overwhelming as to soon remove all opposition and compel its acceptation. Schwann, in 1837, proved that putrefaction could not take place when the substance was supplied with air previously calcined. In other words, that the putrefying germs were in the atmosphere, and were destroyed by heat. These experiments were repeated by Pasteur, and, later, by Prof. Tyndall, who have shown that putrefaction may be prevented by simple filtration of the air through cotton, wool, or even by allowing it to subside, as Prof. Tyndall showed, in a box moistened with glycerin. From experiments of the latter, it is inferred that these germs float through the air in groups; and, being deposited, or coming in contact with suitable material for their development, inoculate it, and propagate with remarkable rapidity.

Believing that such is the true theory regarding fermentation and putrefaction, are we not justified in accepting the same theory regarding infection? Diseases, especially infectious diseases, are characterized by an action similar to fermentation; in fact, are not the very processes of life processes of fermentation? We have, undoubtedly, in certain diseases micro-organisms peculiar to that disease, as Koch's Bacilli tuberculosis and comma or cholera bacilli, and Pasteur's bacilli of hydrophobia.

It is not within the limit of this paper to discuss the great mass of controversy that the announcements of Koch's discoveries have called forth, whether the bacilli are the cause or only attendant circumstances of tuberculosis and cholera. Yet it appears very similar to the discussion caused by Pasteur's discovery of the germs of fermentation. There is, however, one announcement that appears to us rather a confirmation than a rebuttal of Koch's theory,

* Chem. News, 1884. "Pasteur and the Germ Theory."

namely, that Dr. Richards has succeeded in inoculating a pig with a poison separated from the excreta of a cholera patient.* The Doctor imagines that this poison is the infection of cholera. Is it not logical, reasoning by analogy, to suppose that as fermentation results in the formation of chemical products; and, as Dr. Angus Smith long ago observed, that bacteria gave off hydrogen; and, as recently shown, they decompose water, liberating hydrogen and appropriating to themselves the hydroxyl group; † and, as ptomaines are said to be the result of bacteria fermentation,‡ I ask, is it not possible that there may actually be produced as a result of this bacilli growth, or cholera fermentation, as it were, a ptomaine or similar substance? §

We shall consider it, then, as an established fact that epidemic diseases are actually caused by these micro-organisms; that these germs are capable of blood poisoning, which may be truthfully classed as a fermentation, as it is a decomposition caused by the act of nutrition of the living cell, whereby it reproduces in incalculable number the specific septic germ that gave it birth. These, finding suitable nourishment (for, as Koch says, what is food for one is poison to another), gradually infect all the animal fluids, and are again discharged in the breath, perspiration, excreta, and secretions, forming vehicles for the further distribution of the contagium.

The air and water, thus contaminated by secretions and excreta, become the great vehicles for the propagation of diseases, and a single spark of infected matter accidentally entering the lungs, the mouth, or even lodging on the skin of an individual whose system, from various reasons, has not sufficient vitality to throw it off (the germ theory supposes a continual fight between these

* Chemist and Druggist, May, 1884.

† Year Book of Pharmacy, 1884.

‡ Ibid.

§ Since writing the above I have come across the following in the Chem. News for Feb. 27, 1885, page 97, in an article on the modifications produced in the chemical composition of certain animal fluids by the influence of epidemic cholera: "The excrements contained a relatively high proportion of urea and of sodium chloride. The ptomaine present is very rapidly reduced on treatment with a mixture of potassium ferricyanide and ferric chloride. The author and his assistant suffered from incipient poisoning in consequence of inhaling the vapor of the ptomaine."

microbes for the survival of the fittest), fires the mass, and the animal economy, as it were, reduced to a touchwood state, burns till it is consumed.

No poison, as yet known, can compare with the energetic action of these agents of infectious disease. A poison may be organic but not organized. It may kill with far greater rapidity than the contagium of infection; but, unlike this contagium, it cannot multiply itself in the animal economy to such an extent as to endow, within a few hours, every portion of its juices with the power of producing similar results.

DISINFECTION.

In the Levitical law, and the many mentions in the early Greek and Latin literature, we find sufficient proof that the value of disinfectants, in destroying filth and decomposition, and in preventing disease, was early recognized. The use of these agents for embalming is certainly beyond all historical record. The modern history of disinfectants began in the 17th century. In 1732, Dr. Petit made a series of experiments on antiseptics, and their value in preserving meat. His experiments were shortly followed by those of Sir John Pringle and Dr. MacBride. In 1780, Dr. Carmichael Smyth recommended fumigating with nitrous acid, and in 1792 Foucroy introduced chlorine as a fumigant. The bulk of the investigations on disinfection, and the particular value of disinfectants, have been undertaken in the last forty years, and in the later investigations the tendency has been to study especially the influence of these various chemical agents on micro-organisms. Formerly the tendency was to study their power of preventing fermentation, or their antiseptic value.

Disinfectants may be classified as, 1st, natural or mechanical and, 2d, chemical. The latter may be again divided into (*a*) those which act by destroying, oxidizing, or neutralizing the noxious substances, forming new compounds, in themselves harmless absorbents, and (*b*) those which act by so fixing the putrefying matter, or antisepting it, as to prevent further putrefaction. These are antiseptics, or, as Dr. Angus Smith calls them, colytics.

The natural disinfectants, air, water, soil, heat, and cold, are the most important. Air is at once the great purifier

and the great source of contamination. These words of Bishop Berkeley, written in 1744, express the fact so truthfully that, in the light of modern science, they could hardly be improved upon: "Nothing ferments, vegetates, or putrefies without air, which operates with all the virtues of the bodies included in it, that is, of all nature. . . . The air, therefore, is an active mass of numberless different principles, the general sources of corruption and generation; on the one hand dividing, abrading, and carrying off the particles of bodies, that is, corrupting or dissolving them; on the other, producing new ones into being, destroying and bestowing forms without intermission."

The air coming in intimate contact with the organic matter everywhere tends to oxidize and destroy it. This oxidation must take place in the lower stratum of the atmosphere, for it is here that the organic matter abounds; the higher the atmosphere, the purer it is. Hence we see the benefit of ventilation and of winds in exposing new surfaces of the air and removing the old or foul to be oxidized. If the air was to remain stationary for any length of time, it would soon become heavily laden with the germs of disease, noxious gases and vapors, all detrimental to health; but by the influence of winds the atmosphere is constantly undergoing change, and by mixing with the upper strata the organic matter is diffused and oxidized and the air rendered pure and endurable. Another great source of purification in the air is by ozone, or, as claimed by some authorities, peroxide of hydrogen, which at times is noticed in the atmosphere. These two substances, the most active oxidizing agents known, are usually produced by thunder storms.

The rain, coming down from above, absorbs a great portion of the organic matters in the air, and carrying them to the ground, where the soil absorbs them, brings them in a finely divided state in contact with the oxygen or air, previously absorbed, by which means they are quickly destroyed. Similar to the action of the soil is the action of sand, charcoal, and even of lime, when used as disinfectants. Drainage, as a means of disinfection, is from time immemorial.

It is well known that putrefaction and fermentation are most active at a temperature of 75° to 80° F., and that

boiling, or even raising the temperature to 140° F., delays putrefaction. Vaccine matter is destroyed at a temperature of 140 F. At a temperature of 212° F., according to Koch, bacteria are destroyed, but spore-producing bacteria require a much higher heat, about 284° F. being required, with an exposure of about three hours. Moist heat is a great deal more penetrating, and consequently more effective. Boiling water is said to be sufficient. Likewise, cold prevents putrefaction, and freezing seems to preserve animal substances almost indefinitely. Cold also condenses and removes putrefying matter from the air. Putrefaction is diminished to a mere trifle at 54° F., and below that point gradually diminishes till, at the freezing point, it is practically *nil.* Cold, unlike heat, does not destroy contagion, but only renders it inactive.

Aerial disinfecton is accomplished by means of fumigants, such as nitrous acid, chlorine, bromine, sulphurous acid, acetic acid, etc.

On treating copper with dilute nitric acid we have liberated nitrogen dioxide (N_2O_2), which, coming in contact with the air, is immediately oxidized, becoming N_2O_4, the characteristic orange vapors commonly spoken of as nitrous acid or hyponitric acid fumes. This is one of the most powerful oxidizing agents and fumigants that we have. But it requires chemical skill in manipulating, and the use of dangerous acids, and when inhaled is exceedingly dangerous, even fatal, and so is an agent that could hardly become a popular and practical disinfectant. The writer would suggest the following as a safe method for the gradual liberation of these fumes. On slowly adding saltpetre to an acid solution of ferrous sulphate, there will be gradually liberated this gas, according to the equation,

$$6FeSO_4+4H_2SO_4+2KNO_3=3Fe_2(SO_4)_3+K_2SO_4+4H_2O+N_2O_2$$

Sulphurous acid gas was known and used as a fumigant in very early days. Formed by the burning of sulphur, it was used in the streets during epidemic diseases. It is still the popular disinfectant for bales of rags, paper, etc. It is very irritating, and could not be used in a house with any degree of safety, especially not where there are patients. When used, however, the best method is to lay a small lump of sulphur in a saucer, and pour over it

a little alcohol, and ignite. Late investigations by Koch, Wolff,* and Sternberg,† prove sulphurous acid to have very little effect on disease germs. While Dr. Sternberg succeeded in destroying vaccine matter by a very weak solution, Wolff says that "to such organisms as have once passed into a permanent condition, the sulphurous acid gas, even in a high degree of concentration, is utterly harmless, provided they are dry. It is true that, by moistening them, all infectious matter becomes much more susceptible to the killing power of sulphurous gas. But the presence of water by no means affords absolute security, and it has been specially observed that spores, arrived at the permanent state, do not at all lose their capability of developing, if they are moistened, and placed for twenty-four hours in a tightly closed room which contains no less than five volumes per cent. of that gas." Equally unsuccessful were the experiments of Dr. Sternberg; and, although reluctant to abandon, as he says, "an agent which enjoys the confidence of practical sanitarians," he is compelled to admit that much of the so-called disinfection with this agent is a "farce."

Chlorine is one of the most powerful fumigants we have. For the disinfection of sick rooms it is best prepared according to the following:

CHLORINE DISINFECTING PREPARATION.‡

Take of:

Common salt .... 1,800 parts.
Binoxide of manganese.............. 1,875 "

Grind them together into a fine powder, and put up the powder in packages containing about 195 grains each. Each of these packages requires half a fluid ounce of diluted sulphuric acid (45 parts acid to 21 parts water). The powder, placed in a saucer, is moistened with the acid, and then gradually liberates chlorine.

Chlorine may be quickly generated by adding hydrochloric acid to chloride of lime, or, very gradually, by occasionally adding a crystal of potassium chlorate to hydrochloric acid.

---

* Year Book of Pharmacy, 1883.

† Medical News, March 21, 1885.

‡ Parrish's Treatise on Pharmacy, Wiegand, 174.

Bromine and iodine are very similar to chlorine in their action, but are not only expensive, but bromine is too dangerous and difficult to handle. It may be urged against all these fumigant disinfectants that they are irritating; and, in quantity sufficient to prove effectual in destroying germs and putrefaction, would be entirely irrespirable, and even dangerous. They are very readily diffused, and so it would be difficult to obtain a strength sufficient to be valuable. They could never be used as popular indoor disinfectants; for not only are they irritating and irrespirable, but are also destructive, oxidizing, bleaching, and destroying all clothing, carpets, furniture, etc.

Among the chemical substances acting by oxidation only are potassium permanganate and chromic acid. The first of these, introduced as Condy's fluid, has been used with some success, and, as Koch says, is effectual in 5 per cent. solutions. Its action is immediate, destroying organic matter, and being itself reduced to oxide of manganese. Its action is chemical, and, as such, is limited only to the destruction of a definite amount of organic matter, and, of course, its own reduction; and, were it as cheap as chloride of lime, and used in same quantity, would make a most excellent disinfectant. The quantity required to disinfect water closets, sewers, and other places abounding in foul matter, would be tremendous; and, as Sternberg shows, it acts only while in excess, or sufficiently so to destroy all organic matter, leaving not sufficient pabulum for the development of spores.* Very similar is the action of chromic acid. Ozone and hydrogen peroxide are both powerful oxidizing agents; and, could they be produced in quantity readily and cheaply, would certainly be the desideratum as a disinfectant.

Chloride of lime is at once the most practical and most used for obtaining chlorine, and is undoubtedly one of the strongest of the class of deodorizers, but it acts only on the gases of putrefaction, and does not destroy the putrefying substance.

If the whole duty of a disinfectant were to destroy bad odors, then any metallic salt which will absorb these would be the desideratum, and the many metallic solutions, such as Ledoyrus' (lead nitrate), Burnett's (zinc

---

* Medical News, Jan. 10, 1885.

chloride), aluminium chloride, manganese chloride, ferrous sulphate, etc., would be sufficient. Any of these solutions will absorb the sulphuretted hydrogen and other noxious gases of putrefaction.

To those agents that destroy or antisept putrefaction must we look for the greatest benefit from disinfection. The most powerful antiseptics are the salts of mercury; some metallic salts, such as zinc chloride and aluminium chloride; sulphates, such as aluminium, iron, and copper; carbolic and cresylic acids, benzoic acid, salicylic acid, and a few other chemicals. Corrosive sublimate is undoubtedly the greatest practical antiseptic as well as germicide.

Carbolic acid is, for several reasons, peculiarly adapted as an antiseptic; and while its germicide power is, perhaps, lower than that of some few antiseptics, its antiseptic value is peculiar and remarkable. It has scarcely any action on the fœtid gases of putrefaction, but it attacks the cause which produces them, and, at the same time, puts the organic matter in such a state that it never reacquires its tendency to putrefy. As Dr. Crace Calvert says: "If it is desirable to prevent decomposition of organic matter (and, in my opinion, that is the point to be aimed at, for prevention is better than cure), then carbolic and cresylic acids are the only two substances which attain this object—*destruction of food, or source of nourishment, of the germ.*" A great deal of the popular objection to carbolic acid, on account of the odor, is due to the poor quality of the acid used. This objection has also been greatly magnified by the advertisements of certain odorless disinfectants. Raw flesh, containing 0·05 per cent., remained clear and sweet for four weeks, and, if larger percentage were used, still longer. Schroeter considered a solution containing 0·1 per cent. one in which no low organisms can exist, and that a dilution of 0·01 per cent. will retard their development for some time. Sternberg found 0·2 per cent. was antiseptic, but required 1 per cent. for germicide effect.

The peculiar action of this class of disinfectants is due to their power of coagulating albuminous substances, forming insoluble precipitates with them, thereby preventing chemical change and the formation of volatile and odorous principles. This property seems to have been

early recognized, for we find Dr. Petit in 1732 saying that "as corruption comes from the separation of particles, so preservation is attained by contracting them, or drawing them closer, as is done by dry air and astringents." Hence we find Sir John Pringle recommending the use of metallic salts, and Dr. MacBride using acids, gum resins, plants, and roots, all containing an astringent which coagulates albumen. As Dr. MacBride says: "Astringent mineral acids and ardent spirits not only absorb the matter from the putrescent substance, but likewise crisp up its fibres, and thereby render it so hard and durable that no change of combination will take place for years."

It is extremely difficult to obtain by experimentation an exact valuation of disinfectants. To the chemist, disinfection is merely a process of destroying and preventing further chemical action, and he values a disinfectant by its oxidizing or antiseptic power. To the biologist, disinfection is a process of destroying or preventing further growth of germs, and he measures the value of disinfectants by their germicide effect on certain micro-organisms, which, for the experiment, are usually artificially cultivated. This class of scientists would limit the meaning of the word disinfectant to germicide. We must protest against any such restricted meaning. While such may be primarily the object of disinfection, it would not be perfect without deodorizing. In practice the words deodorizer and disinfectant have become almost synonymous.

The difficulty of carrying on such a series of experiments is truly great, and experiments on cultured micro-organisms are too often unsatisfactory, and may widely differ. Thus, Koch, experimenting on bacteria, says that zinc chloride has no value as a germicide, as bacteria treated with a 5 per cent. solution of that salt for 24 hours were not destroyed, but subsequently developed in a 0·5 per cent. solution. Dr. Geo. M. Sternberg says he finds that salt not efficient below 2 per cent. In the report of the Department of Agriculture for 1880, I find it reported that the micrococci of swine plague are effectually destroyed by 0·33 per cent. solution. Koch recognizes this difficulty, and says: "The mode of action of individual disinfectants has not been sufficiently investigated, because of our incomplete knowledge of the infectious matter. An efficient dis

infectant ought, in that author's opinion, to kill all living organisms, and render all germs innoxious, within 24 hours. To test a disinfectant thoroughly, its action must be tried on all disease-producing matter, and under conditions exactly similar to those in which it is used in practice. Thus a disinfectant which does not kill fungi would be of no use in contagious skin diseases, while one which did not destroy bacteria would be insufficient in diseases caused by these micro-organisms.* In his estimation, the only effective disinfectants, besides chlorine, bromine, and iodine, are corrosive sublimate, osmic acid, and potassium permanganate, the latter acting only in 5 per cent. solutions.

Numerous tables have been published on the values of disinfectants, but will not be here inserted, owing to their length and the difficulty of any abridgment.†

The perfect, or ideal, disinfectant must possess the following properties: It should immediately destroy or mask bad odors, and absorb the noxious products of putrefaction, and so act on the organic substances as to prevent further putrefaction, and destroy all germs that may have been formed. It must be cheap, and not of itself dangerous or offensive. A substance may be an excellent antiseptic, but possess little or no germicide action, as, for instance, sulphate of iron, which Sternberg found an effective antiseptic in 0·2 per cent., but possessing little or no germicide action. A substance that is a germicide must necessarily be antiseptic also. Corrosive sublimate answers more nearly the requirements of a perfect disinfectant than any substance we have. Yet it has some drawbacks, mostly chemical, which we must notice. Corrosive sublimate, like all other chemicals, is of value just as long as soluble and remaining as chloride. The greatest need of disinfectants is where the greatest amount of organic matter abounds, as in water closets, etc., and, as is well known, corrosive sublimate is precipitated by organic matter, especially by albuminous substances. Again, 27·5 gm. of corrosive sublimate are destroyed by every 34 gm. of sul-

* Amer. Jour. of Pharmacy, 1883.

† Table of Bucholtz, Encyclopædia of Chemistry, Lippincott's. Table of M. Miguel, Year Book of Pharmacy, 1884. Tables of Dr. Geo. M. Sternberg, Amer. Jour. of Medical Science, April, 1883.

phuretted hydrogen, or 1 gm. of that gas will neutralize nearly 8 gm. of corrosive sublimate, consequently 500 c. c. of the solution as proposed by Dr. Sternberg (1 gm. to 500 c. c.) would require only about 84 c. c. of sulphuretted hydrogen to entirely destroy its effects. The solution as proposed by the Doctor will answer for disinfecting excreta, vomit, etc., for which it is proposed. Corrosive sublimate is comparatively easy to decompose, and the writer was somewhat surprised to find the following formula recommended in the report of the Committee on Disinfectants of the American Public Health Association*: One pound of chloride of lime, one ounce of corrosive sublimate, nine pounds of plaster of Paris. Pulverize the corrosive sublimate, and mix thoroughly with the plaster of Paris. Then add the chloride of lime, and mix well. All chloride of lime is alkaline, and as a result, as soon as this mixture is thrown on any moist substance, excreta or otherwise, we have the mercuric oxide formed, which may perhaps possess some slight germicide or antiseptic properties, but certainly was not what was intended.

The following mixture I have used for disinfecting, and have had very satisfactory results. Equally successful have been a series of small laboratory experiments on preservation of meats, urine, sugar solution, etc.

Take of corrosive sublimate.	2	parts
Carbolic acid, cryst	5	"
Ferrous sulphate, air dried	100	"

Thoroughly ground together. This formula makes a powder perfectly soluble, and one in which the corrosive sublimate is largely diluted with copperas, which, having great affinity for the sulphuretted hydrogen, ammonium sulphide, and organic matter, preserves the germicide effect of the corrosive sublimate. The antiseptic powers of both carbolic acid and copperas are thoroughly established. The carbolic acid may be omitted if objectionable. The following formula is practically the same, but I have used copper sulphate in place of the ferrous sulphate, as yielding a more permanently clear solution:

Take of corrosive sublimate..............	1 drachm.
Copper sulphate..........................	1 ounce.
Water...............	1 pint.

* Medical News, April 18, 1885.

This makes a concentrated, odorless, and efficient disinfectant for use in sick rooms, to disinfect the stools of patients, etc. When used, 1 ounce should be diluted with 3 of water.

PREVENTION.

"Prevention," says Calvert, "is better than cure." We have, in disinfection, which, if thorough, is the destruction of all infected matter, a practical means of prevention. Germs, and necessarily disease, will propagate only where there is sufficient decomposing matter to nourish them. Of prime importance is the keeping of the system in a proper healthy condition that it may resist the attacks of disease. Of equal importance is a proper attention to the quality of the food and drink and to the cleanliness of person and clothing.

Another means of prevention suggested by the germ theory is the administration of prophylactics. The germs of disease, lodging in the lungs or in the fluids of the body, and finding proper nourishment, soon develop into disease. If, now, there could be introduced into the system any substance which would prevent the growth of, or destroy, these germs, such a means of prevention would be a great desideratum. Various substances have been proposed for this purpose, such as zinc sulphate, sulphocarbolates, benzoates, salicylates, thymol, permanganate of potassium, etc. At present, we know of no practical prophylactics, for, as Dr. Sternberg says, those substances possessing the greatest germicide effect could not be administered in quantity sufficient to produce such an effect and be safe.*

Those who are not too skeptical can see that in prevention by inoculation lies the great field of future medical advancement. If vaccination is of any value in the prevention of small-pox, and but few medical men doubt its value, why cannot the same be accomplished regarding other epidemic diseases? While we cannot, with our present knowledge, understand the changes which the system undergoes that make vaccination proof against small-pox, we do know that some change has taken place. Whether a peculiar substance exists in the blood, which is the nourishment for the small-pox germ and

* Amer. Journal Medical Science, April, 1883.

which the vaccine germ destroys, or whether the change is due to some peculiar subtile chemical change which it produces, we are as yet unable to say.

Three-quarters of a century after Jenner's classic discovery we find the subject again taken up by Pasteur. He proposes, by diluting the virus of epidemic diseases, by producing attenuations by culture of these micro-organisms, to gradually modify their intensity or vitality sufficiently to inoculate subjects with these dilutions, and so produce mild forms of these diseases, and in the future to render such subjects proof against these diseases. As Jenner was accused of attempting to brutalize mankind by introducing diseased matter into the human system, and as vaccination was denounced from the pulpit as diabolical, so we have Pasteur ridiculed and denounced. But if these believers and workers in this theory (and they are truly making some progress) will but follow the advice John Hunter gave Jenner, "Don't think, but try; be patient, be accurate," they will compel the scientific world to accept their theory, and in the near future inoculation will be as popular as vaccination. And perhaps some Cuvier of the future will say of inoculation as that scientist said of vaccination: "If vaccination was the only discovery of the epoch, it would serve to render the period illustrious forever, yet it knocked twenty times in vain at the doors of the academies."

G. M. B.

DISINFECTANTS AND THEIR USE.

No. 16.

History.—Though of comparatively recent origin, disinfectants have been empirically known for a number of years. Formerly it was thought that foul smelling and pungent substances had powers of preventing the spread of disease. It is only of late that disinfection scientifically applied has received the attention that it deserves, this being especially true of places where large masses are congregated; for where prior to this era it was left to the individual to protect himself, now it forms the duty of men trained to that purpose. To-day such epidemics as were wont once to destroy their thousands are seldom seen. Is this due to an appreciation of disinfectants?

Disinfectants are those means used to destroy the contagia and prevent the spread of disease. Disinfection is the proper application of these means.

In the use of disinfectants it is essential to know: First, the life history and characteristics of the contagia; second, to understand the effect of the disinfectant upon them; third, to know the easiest and most certain method of applying disinfectants.

In the first—the germ theory being accepted, for without it there would be no need for disinfectants—we observe that all known contagia capable of producing disease of like kind in different persons belong to the lowest order of organic life or the schizomycetes. This class of organized beings is composed of many known and (probably) a greater number of unknown varieties. Many of these varieties approach the limit of visibility, even with the highest powers of the microscope, and their presence in animal tissue is exceedingly difficult to detect without the use of reagents and special staining material. Commonly known under the name of bacteria, they exist everywhere, and different observers give their varieties innumerable names. Organically, they are unicellular, and their growth

is longitudinal, with transverse subdivision of new cells. Chemically, their composition is largely (according to Von Neucke, 1880) of an albuminoid matter; a fact which will be more particularly noticed in connection with the effect of especial germicides. The bacteria have been named and classified into numerous varieties by Cohn, Koch, Klebs, etc., but by far the greater number of the named varieties exist in seemingly harmless relations to man. Of those having connection with and probably causing disease, we have the Bacillus tuberculosis, B. anthracis, B. malariæ, and possibly much disputed comma bacillus of Koch.

The media by which these infectious, contagious, or miasmatic particles of organic matter are conveyed from place to place, and from person to person, are: *First*, that most commonly selected by them, the atmosphere; *second*, water; and *third*, clothing, bedding, stools, etc.

That these organic beings can be conveyed by the air is an undoubted fact, and, under favorable circumstances, they may be conveyed considerable distances, as, for example, Darwin's observation of organic particles on the Beagle. Certain miasmatic and epidemic diseases are much more liable to infect the air than others; malaria, yellow fever, and cholera are the most notable instances.

Water forms a very common medium for the infectious particles, and more especially is this true of diseases having the seat of their characteristic lesion in the digestive tract, such as typhoid fever, dysentery, etc.

The clothing and bedding sometimes convey the poison to long distances, and especial care should be taken with them in that class of disease having cutaneous lesions. All of the above may be a means of communicating the specific poison of the same disease, and it is often a matter of impossibility to state which was the instrument of communication. It is necessary, therefore, to be equally cautious in the disinfection of each.

Having now in brief disposed of the characteristics of the bacteria, we will examine the effects of disinfectants upon them, premising that, being organic bodies, they must be subject to the same laws as other organized beings. Bacteria are susceptible to changes of temperature, both as to heat and cold. An elevation of temperature, at first

causing increased activity, if carried to an excess will completely destroy all life. The maximum temperature at which it is possible to exist is stated by Von Teighen to be from 70° to 74 °C.; while this is true of the bacteria, we must remember that it requires a much greater degree of heat to destroy their spores; the temperature required for this purpose is variously stated to be from 140° to 170°. Heat, then, either dry or in the shape of steam (which is to be preferred), powerfully affects the life of bacteria.

Any poison to organic life may be used as a disinfectant, but those mostly in favor at the present day are such agents as are preventive oxidizers or reducing agents, the theory of their action being that the bacteria are definite chemical substances capable of being converted into an innocuous form. An exception to these is corrosive sublimate, which, besides its effect as a poison to organic life, *per se*, has a powerful affinity for albumen, forming with that body an insoluble compound.

The action of disinfectants, then, on bacteria is not difficult to understand; some act as poisons to organic life, others change their chemical composition, and others again alter the surrounding media so as to interfere with their nutrition.

The action of the disinfectant presupposes of course that it comes either in absolute contact with the bacteria or at least is diffused in the media. Here the absurdity in the use of many of the so-called disinfectants is brought forcibly before us; for in the face of this our pseudo-scientific sanitarians will persist in sprinkling around our dwellings a few ounces of—generally, a very inferior article, too—carbolic acid, lime, copperas, or the like. A small modicum of common sense should have taught us better long ere this; for how, in the name of science, can a few drops of carbolic acid on the floor of a room penetrate into the cracks and crannies wherein the germs lie hidden? How can a substance so slightly volatile seize upon the floating germs, and devour them? Our sanitarians who continue to use carbolic acid and the like non-volatile—and, in some instances, even insoluble—substances should first catch their germ, and then destroy him by gently putting a few drops of poison down his œsophagus—if he be the happy possessor of one.

In taking up the subject of germicides, our remarks shall be confined to two in particular, which may be considered as our idea of disinfectants par excellence. They are easily obtained, easily applied, and are not costly; and, what is still more to be desired, effective when rightly applied. Heat, in the shape of steam, is our first, and corrosive sublimate our second.

Together these may be used to a wide and varied extent; they may be used to advantage in dwellings, hospitals, ships, and in the disinfection of non-perishable infected cargoes, such as rags, hides, etc.

On a large scale their value as disinfectants should be utilized in the disinfection of foreign shipping, having of course a competent health officer to direct their use. In hospitals and dwellings the plan proposed is this: A standard solution of the corrosive sublimate of any given strength being kept for the purpose, all sinks, privies, sewers, etc., should be disinfected with a quantity of the solution calculated to give a strength of not less than 1:50,000 of total contents. After the recovery, removal, or death of infected persons, the bedding, clothing, etc, of all such should be removed to a compartment for the purpose, and then disinfected by means of steam jets from a boiler containing the solution in proportion of 1:20,000. The steaming should continue for not less than two hours, and the clothing may then be washed and dried. The ward occupied by patients with contagious disease should then—after removal or death—be tightly closed and thoroughly steamed with the solution of bichloride of a strength of 1:20,000. This may be accomplished by having a vessel with a sufficient quantity of water to fill the room with steam (a simple calculation will give it easily, the expansive power of water as to steam being 1:1,645). A better plan, however, would be to have a small movable boiler capable of bearing a pressure of several pounds, which could be connected with the ward by means of piping. The steaming should be kept up for at least 2 or 3 hours, a sufficient quantity of oil or coal being supplied, in case the first method be used, to last that time. The small clothes and those not injured by washing should be either boiled for several hours or washed with the solution of the bichloride, and carefully dried. Stools, vomit, and all ex-

cretions should be very carefully disinfected, first with a solution of bichloride, and then, in the case of stools, etc., having a foul odor, deodorized with a sufficient quantity of a ten per cent. solution of potassium permanganates.

The use of heat and bichloride of mercury for disinfecting vessels arriving from infected ports is especially to be commended. A tug with apparatus for pumping steam into vessels having been provided for that purpose, steam from a solution of the bichloride should be pumped into the suspected vessel until she has been completely filled. In case the cargo be of a nature to be injured by the process, it should be removed before proceeding with the steaming, and disenfected on shore by means of dry heat if possible. The bilge should then be disinfected with a quantity of the solution judged necessary for the purpose. If any case of contagious disease has occurred during the voyage, it will be necessary to proceed to disinfect as has been proposed for dwellings.

Heat, dry and in the shape of steam—superheated if possible—is our best means of preventing the spread of disease; but we must remember that all disinfectants are but playthings if the disease be allowed to obtain a firm hold on populous centres. Then we can only trust to natural causes and lack of material. The plan of disinfection proposed has its difficulties, not the least of which is the danger of poisoning to those using it; but with proper care and precautions these dangers may be in a measure avoided, and we must reflect that the enemy with which we have to deal allows no quarter, and our weapons must be adjusted accordingly

PERIISSEM M. PERI-ISSEM.

DISINFECTANTS AND THEIR USE.

No. 17.

DISINFECTANTS prevent the occurrence and spreading of infectious diseases.

The most common infectious diseases are typhoid fever, scarlet fever, diphtheria, whooping cough, phthisis or consumption, cholera, small-pox, yellow fever, but the contagious property of the latter is being doubted. In selection of disinfectants we should seek for the most effectual, cheapest, and most simple, that it may be brought within the reach of all classes. It should be simple, in order that its proper application can be understood by all, and why it should be effectual is known by all. To carry out disinfection successfully, we must know the nature of the contagious agencies, the media through which they spread, and the effect produced upon them by disinfectants which are supposed to destroy or modify them. A great deal of good can be done by the physician in explaining such points to the public and urging them to the importance of them.

THE NATURE OF THE CONTAGIA.

This is of the utmost importance in some diseases, and has been the subject of some very hot discussions.

In vaccine and varioloid the poison has been proved to exist in small particles, which may be seen by the aid of magnifying powers. The epidermic scales of scarlet fever and the diphtheritic membrane contain the poison, which upon drying and exposure for four weeks still retains its power.

The Discharges of Typhoid Fever and Cholera Patients.—It is thought that the particles of the contagia are a class of organisms which Nageli has separated from the fungi, at present the lowest order of the animate world. They were named bacteria, bacilli, vibrios, spirilla.

Lister, Klebs, Recklinghausen, and others were the first to show the great importance they played in the production of septicæmia, or blood-poisoning. Scientific researches have revealed the bacilli in cholera, consumption, and in fact almost all infectious diseases. It has been controverted by others that the above are not the contagia, on account of their great universality; to meet this argument, it has been surmised that they are not the contagia, but simply the carriers.

The bacteria are furnished with an albuminoid plasma, which, while the bacteria are harmless, may become altered in certain conditions, and thus become poisonous in various specific ways. Bacteria feeding on the blood of typhus patients will become nourished with the morbid plasma, and thus become diseased.

The Media through which they spread.—The pus and epidermis of small-pox.

The epidermis and the mouth and throat epithelium in scarlet fever.

The skin and bronchial secretions in measles.

The discharges of cholera patients.

The evacuations containing the discharged detritus of Peyer's glands in typhoid fever.

The Effect produced upon them by Disinfectants which are supposed to destroy or modify them.—One of our most valuable suggestions was that of Dr. William Budd. He suggested that disinfection be more thoroughly applied to the origin of the infection. The more closely this is investigated, the more complete will be our means of disinfection.

In *exanthemata*, or eruptions of the skin, and *scarlet fever* the points to attack are the skin and throat. The skin should be rubbed, from the commencement of the rash until complete desquamation, with camphorated oil and other suitable applications. The throat should be washed with a solution of permanganate of potash or sulphurous acid of suitable strength. The clothes should be properly disinfected, which will be considered farther on.

Small-pox.—The discharges of the mouth, nose, and eye are to be attacked.

There is some difficulty with the skin, as inunctions cannot be well applied.

Permanganate of potash or sulphurous acid of the proper strength may be used for the mouth, nose, and eyes. The clothing, bedding, and every article which has been exposed to the contagion requires the most careful attention.

Measles.—Oily applications to the skin, and a solution of chloride of alumina to receive the expectorations.

The spread of *typhoid fever* may be checked by perfect ventilation and complete disinfection of the clothing and surrounding atmosphere.

Typhoid Fever.—The discharges should be disinfected, for which sulphate of copper serves very well. Corrosive sublimate solution has been largely recommended of late, but its extremely poisonous property is its greatest drawback. Independent of this, it is superior to sulphate of copper, and should always be used where the proper facilities for its safety are afforded.

After complete disinfection, they should be thrown in the sewers, and never on manure heaps. The bedclothes, etc., should also be properly disinfected.

Cholera.—The discharges here are also believed to be the active media of conveyance of the disease, and the complete disinfection is of utmost importance.

In 1866 Pettenkofer recommended copperas. It was tried at Frankfort, Halle, Leipzig, in Germany, and at a place near Bristol, without good results. In other places, as Baden, the benefit was doubtful. Permanganate of potash has also been recommended and used without success, and the same may be said of carbolic acid, chlorine, and nitrous acid, which have been largely used for aerial disinfection, with no better results than the above. For aerial disinfection in this case sulphurous acid gas stands unequalled. It is *the* disinfectant for atmosphere in cholera epidemics. The method of preparation and application will be considered farther on. For the disinfection of the discharges, bluestone, or sulphate of copper, and corrosive sublimate stand pre-eminent.

They may be prepared as follows: Dissolve 8 oz. or ½ lb. of coarsely ground or powdered bluestone in one (1) gallon of water, and to this solution one (1) fluid ounce of commercial sulphuric acid should be added.

The discharges contained in a suitable vessel are to be mixed with enough solution of bluestone to completely

permeate and disinfect the mass. It is allowed to remain thus for an hour or more, and then thrown into the sewer. The solution of corrosive sublimate may be made by dissolving two (2) ounces of corrosive sublimate by the aid of one (1) ounce of powdered muriate of ammonia in one (1) gallon of water. To this solution one-half (½) ounce of nitro-muriatic acid should be added.

In event of a cholera visitation this year, our drinking water should be boiled and filtered. The eating of unwholesome food should be avoided, and all fruit should be peeled before eating. Our premises should be in a good, clean condition. Our small outhouses should be whitewashed and ventilated. The media of conveyance are said to arise from the discharges, and are principally conveyed by means of our water and food; therefore boil your water and cook your food thoroughly. The bedclothes and clothes of cholera patients should be thoroughly disinfected according to the directions farther on. The houses should be kept well ventilated.

Pasteur says: "Sprinkle your streets, as dryness will not destroy the microbes, but simply suspends vitality."

The microbes in this condition would be carried about by the wind, and need only to be inhaled and in contact with the mucous membrane and they would thrive with wonderful and fatal rapidity. Scientific researches have revealed the fact that for the growth and development of the germ it requires an alkaline medium.

If such be the state of affairs in cholera epidemics, the sprinkling of streets and the like with acidulated water should be advocated. For this purpose a mixture composed of one (1) ounce of commercial sulphuric acid and one-half (½) ounce of commercial nitric acid to one (1) gallon of water would answer very well. In an epidemic of any severity, the above mixture may be replaced by the following: commercial sulphuric acid one (1) ounce, commercial nitric acid one-half (½) ounce, bluestone one-half (½) pound to each gallon of water. For its application in an extensive way, suitable ways could be arranged. These mixtures cannot be kept in or used with ordinary metallic vessels. In a small way they may be kept in jugs or glass vessels, and when used poured into a bucket and thrown about by means of a broom or some other suitable way.

Ventilation.—Ventilation stands foremost among all disinfectants. Perfect ventilation prevents the formation and accumulation of poisonous vapors and gases. It carries off the poison, which is diluted with air and finally destroyed by oxidation. Let your sick have plenty of fresh air. It refreshes them, hastens convalescence, and increases the chances of recovery. In this disinfection, it is advisable to admit only the purest air. Ventilation should never be practised with air arising from low, damp, and swampy grounds.

Disinfectants are most conveniently arranged in classes, according to the kind of disinfection for which they are most suitable.

Class I.—Disinfection of hospitals, sick chambers, etc.—To disinfect a room, it should be deprived of its furniture, curtains, etc., and these should be separately disinfected. The metallic fixtures may be protected by a coat of varnish. The walls should be well brushed and the woodwork cleanly scrubbed. All outlets or avenues for the disinfectant to escape should be sealed by pasting strips of strong paper over them. They cannot be disinfected while occupied, as the disinfectant must be in poisonous quantities. In the disinfection of very large rooms, or rooms of an odd shape, the disinfectant should be separated, and portions of it placed at different parts of the room, to insure perfect and uniform distribution. These directions are applicable to all disinfectants under Class I.

Sulphurous Oxide.—This is the most effectual and best of all aerial disinfectants, and is the disinfectant in cholera. It has much greater penetrating property than any of the following. It decomposes sulphuretted hydrogen, neutralizes ammonia, and has a most destructive effect upon organic matter. The gas may be generated by the combustion of carbon bisulphide or of sulphur, to which a small portion of spirit has been added to start the combustion.

After the combustion has been started, the room should be closed, and kept in this condition for about four to five hours. It should then be opened, and kept so for about 24 to 36 hours. There should be about one pound used to every 1,000 cubic feet of air. The cubic capacity of a room

may be obtained by multiplying the length and width, and again multiplying the answer by the height.

Chlorine.—Chlorine is about the best and most desirable disinfectant independent of sulphurous oxide. For generating the gas various methods have been proposed, such as the addition of acidulated water to chlorinated lime, or the action of muriatic acid on black oxide of manganese, but the best and most reliable is by the action of sulphuric acid on a mixture of common salt and black oxide of manganese.

To thoroughly disinfect a chamber, it requires about one-fortieth the amount of the cubic capacity of the chamber.

To disinfect a chamber of the capacity of 1,000 cubic feet, the following proportions answer the purpose:

Black oxide of manganese	9 pounds.
Common salt	8½ "
Commercial sulphuric acid..............	15½ "
Water to assist the reaction............	36 pints.

Considering the commercial black oxide of manganese to contain about 60 or 62 per cent. real oxide, and the acid to contain 92 per cent. real acid, the yield will be 25 cubic feet of gas, which multiplied by 40 gives 1,000 cubic feet, of which one-fortieth is chlorine.

The above will be found to be approximately correct. It should remain in the room from six to eight hours. The room should then be opened, and left so for about 24 to 36 hours. It decomposes sulphuretted hydrogen and ammonium sulphide, and is very destructive to organic matter in the air. It has the power of bleaching organic pigments, which should be borne in mind in its application. It acts by indirect oxidation or combustion, and the presence of moisture is essential to its action.

Bromine.—This was largely used during the late civil war. Its fumes are powerfully irritating, and should be largely diluted. The application is about as follows: the room being prepared as before stated, a suitable vessel is placed at a suitable elevation; if the room is very large, or of a peculiar shape, there should be several stations of the like. When all is in readiness, the bottle at the farthest station is opened, and the contents poured into an open

vessel; the operator then passes to the next, and so on till they are all emptied. The door is now locked and sealed, and the room left in this condition for about six to eight hours; it is then opened, and left so for about twenty-four hours. The action and properties are precisely similar to those of chlorine. The presence of moisture is also necessary in this case.

Ozone.—This has been at one time largely recommended as a disinfectant, but its troublesome and even dangerous method of generation has been too great a drawback to permit of its general adoption.

Nitrous Acid ranks as a powerful disinfectant. It is obtained by the action of nitric acid upon copper clippings. It more speedily removes the smell of a deadhouse than any other gas, and has a powerful oxidizing effect upon organic matter. Its oxidizing effect depends upon the ease with which it parts with part of its oxygen, which it again abstracts from the atmosphere, thus becoming a carrier of oxygen.

Carbolic Acid.—Of all disinfectants, carbolic acid stands pre-eminent in reputation. Of all disinfectants, none has been so overestimated as the above. It deodorizes by simply concealing the odor with that of its own, but does not destroy it.

It retards the rapidity of putrefaction of animal matter, and arrests its growth, but will not destroy it. The precise mode of its action is uncertain, but the supposition is that it acts by the coagulation of albumen. If air be drawn from sulphuric acid over some fresh fæcal matter, there is a rapid appearance of fungi upon it. If the air be now substituted for some that has been drawn from carbolic acid, the fungi become brown, discolored, and apparently dead; but on again substituting washed air they revive, showing that it is only a restraint of putrefaction and a limitation of growth of low forms of life.

Class II.—Disinfection of discharges and sputum.—Disinfection of discharges has already been considered under the head of typhoid fever and cholera. Disinfection of sputum: The sputum of patients affected with contagious diseases may be received in a suitable vessel containing Labarraque's solution, or a solution of chlorinated lime, 2 parts to 100.

Class III.—Disinfection of wearing apparel, bedclothes, and other fabrics.—All articles mentioned under this head, which have been exposed to contagia, should be immediately disinfected after use. They should, by all means, never be sent to a laundry. They should be disinfected on the premises. Articles of a trifling value should be destroyed by fire at the nearest possible place.

Dry heat is one of our efficient disinfectants for this class. The articles are hung in disinfecting chambers, a slight distance apart, and away from the wall. The chambers are supplied with a hot air blast below and an exit tube above, to carry off the microbes or contagia. The principal objection is the difficulty experienced in regulating the temperature. If the clothing is infected with lice, it should always, if possible, be subjected to heat. The clothing and bedding of small-pox patients should also be subjected to heat before washing. The articles should then be thrown into a tub of water to which some solution of chlorinated lime has been added in proportion of one gallon of saturated solution to twenty-five gallons of water. They should then be boiled for two or three hours in a covered boiler, and then taken out and rinsed in clean water, and washed with soap and water. When they are done, they may be again subjected to dry heat. The boiling with solution of chlorinated lime can be applied to white fabrics only, as the chlorine in the chlorinated lime will destroy organic colors. For colored fabrics the chlorinated lime may be substituted by sulphate of zinc, which is used in proportion of one pound to 120 pints of water.

Fumigation with the fumes of burning sulphur is also very effectual.

Class IV.—Disinfection of gutters, cesspools, cellars, and sheds.—Gutters, properly constructed and in proper condition, require little or no disinfection. They should be kept as clean as possible, and occasionally sprinkled with lime or chlorinated lime.

Cesspools should be provided with proper drainage.

Cellars should be kept clean and well ventilated.

In addition to this, the cesspools and cellars may be sprinkled with lime or chlorinated lime, as in the first case.

Sheds : These should be kept clean, well ventilated, and

thoroughly whitewashed. They should be sprinkled with chlorinated lime.

In conclusion, I would say that such is our system of disinfection of to-day, but there still remain avenues which require further research. The field of investigation in sanitary science is large and laborious.

BINIODIDE.

DISINFECTANTS AND THEIR USE

No. 18.

MOTTO.

Sub sole, nil perfectum est.
Try all, keep the best !

DISINFECTION may comprise three different operations :

Disinfecting agents may be considered as those which destroy the existing germs, check the process of putrefaction, and prevent the spreading of contagious or infectious miasmata.

Antiseptics, as those to prevent and check the process of fermentation, decay, or putrefaction.

Deodorizing agents, as those which destroy the bad flavor or disagreeable, offensive smells.

The various agents for disinfecting are numerous, still different in their effects, and the selection for practical application is governed by experience.

Among the most important agents for *disinfection* we may name :

Permanganate of potassium.
Chloride of lime.
Sulphate of iron (copperas).
Chloride of iron.
Chloride of zinc.
Chloride of aluminium.
Chloride of soda.

Residue from the manufacture of chloride of lime and other chlorine preparations.

Sulphuric, nitric, and muriatic acids, boracic, acetic, pyroligneous acids, wood tar, creasote, methyl, and their derivates, coal tar, carbolic acid, and their derivates, lime from the gasworks (or McDougall's disinfecting powder).

Fumigations of sulphur and liquid sulphurous acid, sulphite of lime and soda, ozone, charcoal, peroxide of hydrogen, etc.

Antiseptics.—Carbolic acid, salicylic acid, benzoic acid, naphtaline alcohol, methyl alcohol, thymol, creasote, quinine, cinchonine, strychnine, tannin, camphor, corrosive sublimate, arsenic (too poisonous for application in general).

Deodorizing agents.—Charcoal, animal coal ; charcoal absorbs about 90 per cent. ammonia and 55 per cent. sulphuretted hydrogen gas.

Residue from coffee.

Including also a great part of the above named disinfectants.

Directions for preparing the most important and practical disinfecting agents :

Solution of permanganate of potassium.—2 parts permanganate of potassium, 100 parts water (4 to 10 parts crude permanganate to 100 water). The crude preparation may be preferable in many cases ; 4 to 5 per cent. of sulphate of iron can be added, and, when much ammonia is disengaged, an addition of 2 to 4 per cent. of sulphuric acid to the solution will make it more effective.

Chloride of lime.—Solution of 2 to 3 parts to 100 parts water ; or spreading the dry material, where moisture is present.

Residue from the manufacture of the chloride of lime or other chlorine preparation is a good disinfecter where circumstances permit its application.

Chlorine fumigations are made by mixing 12 parts salt, 8 parts powdered manganese dioxide, and adding a mixture of 10 to 12 parts of sulphuric acid with equal weight of water, set out in earthen dishes.

Sulphurous acid gas is produced by burning sulphur in earthen or iron pots.

Liquid sulphurous acid should be used when recently made.

Sulphate of iron (copperas) is a good disinfectant, when mixed with the excrement or other evacuations.

Chloride of aluminium, much used in England in liquid or in powder. The liquid consists of 13·9 chloride of aluminium, 3·11 chloride of calcium, 82·33 water, or of 21 per cent. chloride of aluminium, iron, chloride of lime, and water. A similar preparation is made in New York, with addition of some bromine and

iodine. The powder consists of 52·43 chlor. aluminium, 32·15 silica (white sand or clay), 11·51 chlor. calcium, 0·72 chlor. arsen. (chloride of arsenic), fractions of lead and copper.

These two articles may be prepared by taking white clay containing some lime, and mixing with it crude muriatic acid ; after standing some time, the clear liquid is separated, and will answer for the liquid chloride of aluminium. The sediment, after drying, will make the powder of chloride of aluminium.

Chloride of iron, prepared by dissolving oxide of iron in muriatic acid. This preparation is much recommended for disinfecting urine.

Choride of zinc is made in a similar way.

Carbolic acid.—The liquid may be prepared of 2 parts pure carbolic acid to 100 parts of water (warm). Of the impure acid, 4 parts should be used to 100 parts warm water.

Carbolic acid powder is made by mixing 100 parts of either white sand, soil, turf, or sawdust with 2 parts of the pure or 4 parts of the crude carbolic acid with some warm water.

Whitewash with carbolic acid, for rooms, etc., is made by adding 2 to 3 parts carbolic acid to 100 parts whitewash liquid.

A convenient application for sick rooms is formed by saturating pasteboard with the above named carbolic acid preparation, for hanging up in rooms.

Similar to the application of carbolic acid are creasote, thymol.

Arsenious acid, *corrosive sublimate*, and other preparations of oxide of mercury are very strong disinfectants, still very objectionable on account of their severe poisonous properties.

Bromine is a strong disinfectant, also iodine. The difficulty in handling the same, and the high price of these articles, are objections to their general use. Coal tar fumigations are convenient for application in unoccupied rooms.

Ozone.—This natural disinfectant is one of the best for application in sick rooms or inhabited dwellings. Being not so offensive as some of the above named disinfectants,

it may be regulated so as not to molest inhalation. According to Prof. Ludwig, a pure atmospheric air contains 0·01 to 0·02 milligramme of ozone in 100 litres. In places where epidemics are raging, the quantity of ozone in the atmosphere is diminishing. Several directions are published for producing ozone, some practical, some impractical. Referring to the *Druggists Circular*, New York, issue 1882, April, page 54, we find a description of an impractical. If the manganese mixture and the oxalic acid had been separately dispensed, and the oxalic acid was mixed *gradually* to the moistened mixture of the manganesium, no explosion would have taken place in the French pharmacy. On the same page of the *Druggists Circular* reference is made to a severe accident, which happened in the laboratory of the French Society of "Practical" Medicine. If the sulphuric acid is first placed in the generator bottle, and the coarse manganese preparation had been added in quantities of ½ to ¾ teaspoon gradually to the acid, no explosion would have taken place.

The following is a practical way of producing ozone without the danger of explosion:

Take of commercial sulphuric acid (free of arsenic), a suitable quantity, place it in an open china or earthen vessel or wide mouth glass, add gradually ½ to ¾ of a teaspoonful of the crude granulated permanganate of potassium (free of chlorine), with interruption to prevent heating, until, in the course of time, the mixture forms a sticky mass, or till the acid is saturated. If no more gas is disengaged, the brown residue can be mixed with water, and will make an excellent disinfectant for cesspools, etc. A violent generation of ozone interferes with the respiratory organs, while a moderate one will be beneficial.

Directions for applying disinfectants on different occasions:

For beds, bedclothes, wearing apparel, and the like.—Take solution of permanganate of potassium for washing, and for removing the brown color use either a solution of sulphite of soda, or sulphurous acid, or diluted muriatic acid for rinsing the clothes.

For spittoons, chambers, and the like.—These may be rinsed out with carbolic acid water after emptying the

same, and an addition of solution of permanganate of potassium or residue from the chlorine factories may be used.

Privies, cesspools, rags, animal waste, etc., may be treated with solution of permanganate of potassium, with addition of sulphate of iron, and when preferred some carbolic acid water.

The floors of sick rooms, schoolhouses, and other similar apartments should be scoured with a solution of chloride of lime, the walls whitewashed with an addition of 1 or 2 p. c. of carbolic acid to the whitewash liquid. Rooms not occupied should be fumigated with burning sulphur in earthen or iron vessels, and be closed 24 hours before airing the same; open places should be cleaned of all filthy or decayed matter, sprinkled with solution of chloride of lime or residue of the chlorine factories, with the addition of sulphate of iron.

Drinking water may be disinfected by boiling, and, after cooling, keeping the same in earthen covered vessels. Otherwise a small quantity of solution of permanganate of potassium (1-500 or 1-1000 part is in general sufficient) may be added to the water. A carbon filter will purify the water as long as new, and may be cleaned again by heating the same to dark red heat.

Running water, ponds, and gutters may be purified with lime or chloride of lime.

Infected woollen cloths should be heated in an oven up to 220 or 250 degrees Fahr., aired well beaten, and afterward sprinkled with carbolic acid water.

Live animals which have been in connection with infected stuffs should be sprinkled with carbolic acid water, mainly upon the flanks.

People handling infected articles should wash their hands with solution of permanganate of potassium, and remove the brown color of the same according to the directions above given.

For dead bodies, sprinkling with the carbolic acid water, chlorine water, chloride aluminium, is advisable, and if possible, application of chloride of lime by a small opening made into the abdomen.

Dead animals or carcasses should have the abdomen partly opened and poured over with acidulated solution

of permanganate of potassium and chloride of lime, and buried as soon as possible.

The valuable proposition made by Prof. Boettger for dressing ulcerating wounds has been applied by many surgeons with great success. The proceeding consists in saturating collodion wool (guncotton) with a 2 per cent. solution of the permanganate of potassium, and covering the wounds ; the pestiferous smell disappears rapidly, to the relief of the attendants and the surrounding persons. The collodion wool and bandages can be used again by washing the same with solution of permanganate, and, when preferred, discoloring the same according to the above given direction.

The disinfection by heat has been applied in several hospitals, where separate appartments have been arranged for the process.

To a heat of about 250° Fahr., the clothing is exposed from 6 to 8 hours (a higher temperature will destroy the fibre more or less).

In regard to the effects of heat in destroying the infusorial germs, bacteria, bacilla, etc., the physiological opinions differ.

Cohn says : "Boiling or heating up to 212° Fahr. will destroy bacteria."

Hoffmann says: "Boiling in open vessels will require a long time for destroying bacteria ; in closed vessels the destruction is rapid."

Wymann stated that 5 to 6 hours' boiling is required to kill the last germs of organism.

Pasteur's statement is that only a heat of 238° Fahr. will kill all the organisms.

Lex observed vitality after heating a short time to 260° Fahr.

Crace Calvert found that only a heat of 395° Fahr. will destroy all the bacteria.

Some of these statements correspond with those of Koch and Wolfbengel. See *Druggists Circular and Chemical Gazette*, February, 1883, page 29.

In selecting a disinfectant we should pay attention to practicability, effectiveness, cheapness, and harmlessness, also to bring the agent in a close connection with the object to be disinfected. We may destroy the cholera germ in a

person by giving antiseptic tonics such as quinine acidulated with a few drops of hydrochloric acid, and use a weak solution of permanganate of potassium (pure) with a small percentage of muriatic acid for injection.

By the advanced knowledge of electric power and improvement of its application, we might succeed in finding a way for the destruction of germs of infection.

In considering the knowledge of disinfectants, science has still a large field for operation to conquer those innumerable visible and invisible yet active organisms, the enemies of real life.

MOTTO.

Sub sole, nil perfectum est.
Try all, keep the best !

DISINFECTANTS AND THEIR USE.

No. 19.

DISINFECTANTS are substances which absorb, neutralize, or destroy putrescent effluvia and miasmata.

True disinfection is a somewhat harder task to perform than is generally supposed.

It is not so easy to prevent or to destroy growing germs as it is to kill the odors which arise from these causes.

All recent investigations tend to demonstrate that the efficiency of any disinfectant is due to its power of destroying or of rendering inert specific poisons or disease germs, which possess in themselves an independent existence, and which, when introduced into the animal system, under favorable conditions, increase and multiply, thus producing the phenomena of special diseases. Therefore, "antiseptic substances, generally, which check or stop putrefactive decay in organic compounds, by preventing the growth of those minute organisms which produce putrefaction, are, on that account, disinfectants" So, also, "the deodorizers, which act by oxidizing or otherwise changing the chemical constitution of volatile substances disseminated in the air, or which prevent noxious exhalations from organic substances, are, in virtue of these properties, effective disinfectants in certain diseases."—Encyclopædia.

A knowledge of the value of disinfection can be traced to very remote times; the origin of numerous heathen ceremonial practices is clearly based on a perception of the value of disinfection.

Disinfectants may be divided into two great classes, viz.: (1) natural—those produced and existing by nature; (2) artificial—those made by man, by the aid of chemistry.

REMARKS ON THESE DISINFECTANTS.

1. *Natural.*—Nature has provided for us the best and most potent disinfectants: (*a*) air, having an immense

oxidizing influence; (*b*) water, with its purifying effects; (*c*) common earth, with its deodorizing properties.

Pure air is very essential to human life; but there are places and dwelling houses at which and in which pure air has no access. Look at some tenement houses for a moment: closely situated together, having their backs facing on small alleys, in which sunlight has no admittance; how can pure air be found in such places?

Dr. Ben. Lee has given us a few remarks on free ventilation. He says: "It is not always possible to secure free ventilation, and even when it is possible to do so, it is also very desirable to have some additional means of counteracting, and if possible destroying, these poisonous emanations, so that the air which carries them from the sick room or the foul house may carry them, at least, deprived of their deadly potency."

2. All *artificial disinfectants* which are at present known to us may be classed in three categories viz.: (*a*) physical, (*b*) physiological, and (*c*) chemical.

a. As *physical* disinfectants, rank dry heat and hot vapors. Both are powerful agents, but labor under the disadvantage of having but a limited applicability as to the area involved. Heat is a power chiefly relied on for purifying clothing, bedding, and textile substances generally. Different degrees of temperature are required for the destruction of the virus of various diseases; but as clothing, etc., can be exposed to a heat of about 250° Fahr. without injury, provision is made for submitting articles to nearly that temperature.

The result of a series of experiments on the destruction of low germs by heat, made by Dr. Crace Calvert, demonstrates that the germ of disease will withstand a temperature of 300° Fahr. Exposure to such a heat as this injures the fibres of all kinds of cloth so seriously that they are unfit for further use. It is therefore evident that the mere agency of heat cannot be depended upon for the destruction of the germs of disease attached to the clothing of persons who have suffered from any contagious disease.

b. The *physiological* method is based on the supposition that the majority of infecting agencies are living organisms, and intends their destruction by drugs which

prove poisonous to them without, in the quantity exhibited, injuring the human organism. The representatives of this group are the following, which are found to be the most powerful in destroying minute forms of life, viz : sulphate of copper, chloride of aluminium, chromic acid and bichromate of potassium, benzoic acid, bromal hydrate, chloral hydrate, hydrocyanic acid, alum, hydrochloride of strychnia, ferrous sulphate, arsenious acid, picric acid, and bichloride of mercury.

The corrosive sublimate is unfit for any extensive use, on account of its powerfully poisonous action on man and animal, even in small quantities.

c. The third group may be divided into two classes : (1) volatile or vaporizable substances which attack impurities in the air ; (2) non-volatile and chemical agents which act on the *diseased* body or discharges therefrom. Of the first class, aerial disinfectants, those most employed are the gaseous sulphurous anhydride, the fumes of nitric, nitrous, and other acid substances, including vaporized carbolic acid, with chlorine gas, and the vapors of bromine and iodine. 2. In this class, oxidizing agents are used, such as potassic manganates and permanganates, the solutions of the so-called chlorides of lime, soda, and potash, with the chlorides of aluminium and zinc, soluble sulphates and sulphites, solutions of sulphurous acid and chlorine gas, and the tar products, carbolic, cresylic, and salicylic acids.

REMARKS ON CHEMICAL DISINFECTANTS.

a. Gaseous.

1. *Sulphurous acid gas.*—Fumigations by this gas are mentioned by Homer. The most practicable method of preparing this gas is by the combustion of sulphur, with enough alcohol to ignite it. In a communication to the French Academy, M. Dujardin Beaumetz concludes that sulphurous acid is the best of all disinfectants, and shows that all germs and microbes, even those of anthrax, are destroyed in a room in which this gas has been generated. He was able by means of the microscope to confirm the ideas generally held as to the efficacy of this disinfectant, and to prove its superiority to disinfection by *heat.*

This method is used in the hospitals of France. Its chemical action is due to its deoxidizing properties ; it destroys the color and odor of many organic substances.

Its disadvantages are these : apt to set fire to the room, unless the vessels holding it are properly fixed ; doors, windows, etc., must be closed for at least 24 hours ; certain articles must be removed, thus causing some inconvenience ; and last of all, it cannot be employed in a room in which a sick person is confined in bed, at least not made in this way.

2. *Chlorine gas.*—Halle, in 1785, appears to be the first person who used this gas as a disinfectant. Chlorine fumigations are apparently useless to prevent the progress of *cholera* and erysipelas. It was found useless in checking cholera at Moscow. "At the time," says Dr. Albers (*London Medical Gazette*), "that the cholera hospital was filled with clouds of chlorine, then it was that the greatest number of attendants were attacked."

Physiologically, it is a local irritant ; diluted half with air and brought in contact with the skin, produces peculiar sensations ; inhaled in small quantities largely diluted with air, induces a warming sensation in the chest, and increases the bronchial mucus.

3. *Bromine.*—By some authorities, bromine is considered the best of all gases which are used as disinfectants, especially for rooms, houses, etc. It can be employed as a pure vapor, or mixed with air or steam.

Physiologically, it produces cough, a feeling of suffocation, and headache ; stains the cuticle yellowish brown, and continued application acts as an irritant. Disadvantages —its bad odor, its action on the skin, throat, and eyes. If it *must* be used in a *sick room*, it should be kept in well stoppered bottles ; opened with the greatest of care, by those only who know its effects. as, if carelessly handled, its odor might injure the patient.

b. Non-volatile.

1. *Potassic manganate and permanganates* are sometimes used. The same may be said of the solutions of sulphurous acid and chlorine gas ; and also of the two last named substances of the tar products, although the salicylic acid

is more used than the cresylic. The chlorides of aluminium and zinc are more used than the soluble sulphates.

2. The *solutions of the sulphates of iron and copper* are used; the iron salt especially. The general method in using this salt is to pour water upon it, in a vessel, and allow it to stand. I should think that if the solution were thrown into the place when the dirt is, and allowed to mix with it, it would do more good than allowing it to stand in open receivers. It has one advantage—it is *inodorous.*

3. *Carbolic acid.*—This acid is used to destroy the lower grades of organic life; it acts as an antiseptic by checking proper fermentations. As regards the mere correction of offensive odors, by decomposition or neutralization of the effluvia on which the odor depends, there are other medicines much more energetic than carbolic acid. Indeed, the probability is that it exercises no deodorizing influence beyond that of merely disguising the smell of the offensive exhalations by its own bad odor. Dr. W. W. Carpenter, in his report to *The Medical Brief* (Nov., 1878, vol. vi., No. 11), says that "during an epidemic of small-pox in San Francisco, Prof. J. T. Morse, then city physician, threw carbolic acid into every available place, and still the *disease gained.* He then began sprinkling with chloride of lime, and filling sinks, etc., with sulphate of iron and copper."

"A decision rendered by a convention of doctors and chemists, held at Berlin, was that carbolic acid is almost, if not quite, inert as a disinfectant."—*Medical Brief.*

4. *Hypochlorite of calcium* (*chlorinated lime*).—This is largely used as a disinfectant. It is the alkaline hypochlorite, which is substitued for the chloride, on account of the chloride giving off its gas so quickly, which attacks the organs of respiration, thus precluding its use (the chloride) in inhabited places.

Chlorinated lime exposed to the air and moisture of sick rooms slowly yields hypochlorous acid; the lime absorbs the carbonic acid, the hypochlorous acid breaks up into water, chloric acid, and free chlorine; the chloric acid, being unstable, breaks up into oxygen, water, chlorine, and perchloric acid; the oxygen oxidizes certain substances; the chlorine acts on organic vapors and gases, chiefly by

its affinity for hydrogen, forming hydrochloric acid, which unites with bases to form salts, and leaving oxygen nascent.

The hypochlorites evolve chlorine so slowly as not to produce any noxious effects, though their action on organic matter is very powerful. Bousquet (*Bullet. des Sciences*) states that there are no facts satisfactory enough as to the chemical powers of the hypochlorites to destroy the infectious matter of fevers. He mixed equal parts of chloride of soda and vaccine lymph, and found that the latter still possessed the power of the cow-pox vesicle.

OTHER DISINFECTANTS.

Oxygen is one of immense power. There are no easy ways of producing it in sufficient quantities for disinfecting purposes.

Carbon is one which is used as a disinfectant and absorbent. It may act either as an oxidizer or as a deoxidizer.

It has an advantage over the chlorides, as being inodorous.

It must be recollected that charcoal, in all cases, to exercise the highest powers as a disinfectant and deodorizer, should be both fresh burnt and fresh powdered, and carefully preserved from contact with the air, until about to be employed. From exposure, it loses its valuable properties.

Metallic salts are used sometimes ; they operate by reacting on sulphuretted hydrogen and the hydrosulphurets, by forming insoluble, inodorous sulphurets. They act as disinfectants by fixation.

Ozone.—This gas is the best of all artificial disinfectants, according to Dr. Lee's opinion. There are various ways of preparing it ; but the most easy is by the action of strong sulphuric acid on potassic permanganate. Dr. Lee remarks that "it is an oxidizing agent of the most tremendous activity, always present in the air, and more so when the air is pure, and found at the seashore and mountain tops, always active at work, destroying the products of animal and vegetable decomposition ; that bacteria, brought under its influence in any degree of

concentration, die instantly; destroys foul odors of all kinds; at ordinary temperature oxidizes carbonic oxide into carbonic acid." "An agent possessing such tremendous power, if it could be introduced in a room filled with foul odors, without attacking furniture, persons, etc., would be a great addition to our means of checking fermentation and atmospheric poisoning."

"Ozone has a strong affinity for certain liquids. It is readily absorbed by a solution of an alkaline iodide, converting it into iodate. It oxidizes moistened silver leaf and strips of arsenic in the cold; liberates iodine from iodides; converts sulphites into sulphates; destroys organic coloring matter with the greatest energy; bleaches blue litmus, without first turning it red; discharges the color of sulphate of indigo, by contact alone; renders cork and caoutchouc brittle; decomposes tannic acid, oxalic acid being a product."

Certain well known disinfecting and bleaching agents owe their properties to this constituent.

Physiological action.—Dr. McKendrick of Edinburgh states the following:

1. The inhalation of an atmosphere highly charged with ozone, diminishes the number of respirations per minute.

2. The cardiac pulsations are reduced in strength, and the heart is found beating feebly after systemic death.

3. The blood is found, after death, to be in a venous condition, both in those cases of death in an atmosphere of ozonized air and of ozonized oxygen.

4. The inhalation of an ozonized atmosphere is followed by a lowering of the temperature of the body to the extent of at least 3° to 5° C.

5. The inhalation of ozone does not exercise any appreciable action on the capillary circulation, as seen in the web of the frog's foot under the microscope.

6. In the bodies of frogs killed in an ozonized atmosphere, the reflex activity of the spinal cord is not appreciably affected.

7. The contractility and work power of the muscles is unaffected.

8. The action on the blood disks is similar to that of air.

9. Ciliary action is not affected, provided there is an abundant supply of food.

There are numerous kinds of disinfectants put up by different people, and known under different names, but I believe there is no one which is considered the best.

Dr. Letherby, health officer of the city of London, recommends a mixed chloride and hypochlorite of zinc as a disinfectant for stables, slaughter houses, etc.

A solution of sesquichloride of iron, chloride of manganese, chlorine, and carbolic acid is an excellent disinfectant for streets, cellars, slaughter houses, etc. The sesquichloride of iron has been found by experiment to deodorize more effectually than chloride of lime, sulphate of zinc, or other disinfectants. The iron checks fermentation, the chlorine acts as an oxidizing agent, the carbolic acid acts in directing decomposition and fermentation, and the whole, by its chemical action, decomposes sulphuretted hydrogen.

CONCLUSION.

What is wanted are disinfectants, or a combination of them, which are simple, not dangerous, and not costly. I take these three points into consideration for this reason ; we want disinfectants which are *not costly*, so that the poor class may procure them ; *not dangerous*, so that this class, not having had an extensive education, not only in chemistry, but in practical knowledge, may handle them without injury to themselves or to their household, by fire or explosion ; *simple*, so that they may set them in operation with ease. The reason why I state these facts is that disinfectants, etc., are more wanted and used among the poor class, who are crowded in close quarters, and where there is more sickness, than they are among the richer people.

I would recommend bromine and sulphurous acid in unoccupied rooms, etc. I would use carbolic acid, for cellars, waste pipes, closet, etc., but would not have it standing in a sick room.

For a sick room in which the party is confined to bed, and is likely to stay for some length of time, I would recommend the following plan : Procure three *thick*

glass bottles, having their *bottoms* of the same *thickness*, with *wide mouths*, having tops or covers fitting accurately; the covers to be the shape of an inverted funnel. Into the first, place some sulphuric acid, and gently let fall on top of it twice that amount (by weight) of permanganate of potassium (not more; neither pour the acid on the potash); into the second, place some hypochlorite of lime and a little dilute sulphuric acid, or the lime may be placed on a plate, without using any acid; and into the third, some sulphite of soda, with a little dilute muriatic acid, and lastly some recently burnt charcoal. The charcoal absorbs carbonic acid in the air, expelled by the patient and attendants; the sulphurous acid gas attacks certain matter, and decomposes it; the chlorine sets free oxygen, while its gas attacks other substances, and last, but not least, we have free ozone in small quantities, the best of them all.

I have stated the physiological properties of some of these disinfectants, so that we may pick out the best, which shall act the most powerfully, and have the least effect on people, as regards smell, etc.

"TRICHLOROACETIC ACID."

DISINFECTANTS AND THEIR USE.

No. 20.

DISINFECTANTS have lately been defined as agents capable of destroying the infective power of infective material,* and as agents for removing the causes of infection.† In seeking out the most valuable, much more requires consideration than efficiency in the direction here indicated. We want to know the amount of skill required in their use. Other things being equal, we choose that which requires least. We seek for those that can do the work with a minimum of danger to life or health, and the smallest possible injury to fabrics or their colors. We prefer such as will not damage household ornaments or articles of use. When superstition or ignorance do not mislead, our choice will always lean toward those possessing the least offensive odor or to those that are odorless. Last, but not least, the question of cost comes in. Owing to the large amounts of even the most efficient that must be used, cheapness, especially among the poor, is of the first importance. Not one yet discovered has answered every indication perfectly. In one case our choice is of necessity a solution or liquid, in another gas, or we may discard both for the physical agent heat. As knowledge advances, we may be able to work to better advantage by varying the agent to suit the infection. When the cause of each disease is discovered, and the natural history of such micro-organisms, if any, as excite the same is fully traced, then the conditions best adapted to their destruction will be known. But very few out of the long list of microbicides at our command possess sufficient merit and cheapness to be available as good disinfectants. They all possess objectionable features. Our choice is from such as have a balance of advantages in their favor. Until lately we have known no means of testing their efficiency. A crop of quacks has therefore sprung

* Med. News, vol. xlvi., p. 87.
† Webster's Dictionary.

up, with loud pretensions, who propose to supplement ignorance with wild claims. They know nothing themselves of the germicide power of their much lauded products. A false sense of security is fostered in the public mind by the sale of their goods, and the contagion that a good article would have destroyed is allowed to spread forth, dealing out death on every side. Proprietary medicines can only damage those who take them. Bad proprietary disinfectants are responsible for the deaths of innocent people who had nothing whatever to do with them. Among the hundreds offered for sale, a few only are of value if used of full strength. Disinfectants of every kind must be used in large quantities to be reliable. Only the rich could afford to use enough of the best proprietary article now sold. When thrown into water closets and sewers, or when used in stables, barn yards, or privy vaults, the dilution is so great that they are but little better than water. Dr. Sternberg commends some of them as antiseptics and deodorants, but any good disinfectant or germicide will do better work even in this direction at less than one-thousandth of the cost. He thinks that on this account they are justified in calling them disinfectants.* It is true that the word is so used by very many people, and in the past this meaning was attached to it by all. Our leading encyclopædias seem to endorse this loose method of defining it. It is only within the last few years we have discovered that neither deodorants nor antiseptics, when purely such, have the least power as disinfectants. The reverse of this has been the universal belief, and so the words came to be looked upon as synonymous. If owners of proprietary deodorants and antiseptics are, because of our past ignorance, to be justified in using the name disinfectant, and allowed to continue its use, the more reason is there for those better informed to condemn their preposterous claims. They all pretend to be able to destroy the infective principle of zymotic diseases. Not only this, but some of them declare that all that is necessary to charm away any disease from a house is to hang up a few rags saturated with the stuff, or leave it in saucers in the corners of the room. Whether they imagine that the germs will be accommodating enough to go and partake of

* Med. News, vol. xlvi., p. 145.

it, as flies do of the poison on fly-paper, they do not say. But for this pretence their sale would be so restricted that we would never hear of them away from the neighborhood of the manufacturer. Chemists of boards of health may war with sewer gas, sulphuretted hydrogen, and the products of organic decomposition, but the people never look at remote dangers. Their terror is of immediate infection, and when they buy a disinfectant, it is to destroy the cause of some disease. They will endure the fumes of an open sewer for weeks without expending one cent so long as they think themselves safe from disease. It is because they have been taught to associate the smell with the malady that they try to suppress it. These proprietary deodorants, claiming the title of disinfectants, are therefore dangerous in proportion to their efficiency. By ridding a house of some bad odor, they encourage a dangerous delusion. The prices charged for them are often enormous when compared with the cost of their production. "Girondin" owes its efficiency to the salts of zinc and copper it contains. Its wholesale price is twenty-five times its first cost.* "Chloridum" costs its maker three cents per gallon.† When we come to calculate the germicide value, the waste of money in using the best of them is seen to be startling.

WHAT ARE DEODORANTS?

When charcoal, earth, peat, fresh lime, copperas, or other such substance is scattered over or near a putrefying body, or in a place where damp, foul odors arise, the smell disappears, if a sufficient quantity is used. Such substances may fail to arest the destructive processes to which the odors were due. If the infectious material of any zymotic disease happened to be present, such treatment would not destroy it. Material of this kind, from the most deadly disorders, can exist where there is not the slightest trace of a bad smell. On the other hand, most annoying odors may be found where there is not the least danger of catching any disease. The burning of spices, gums, and fragrant berries, and the scattering around of colognes or essential

---

* Nat. Board of Health Bulletin, vol. i., p. 139.

† Ibid.

oils, is as effectual in masking offensive effluvia as the Indian's plan of rubbing paint upon his face to cover dirt. To suppose that such measures protect from disease is neither less nor more than sheer superstition, however venerable the habit or whatever its genesis. Foul odors should be interpreted as warnings from nature telling of danger ahead. Where they arise, disease can find a fitting centre from which to radiate. The use of deodorants—for such we call the agents that remove only smell—is about as sensible as the removing of the rattles from rattlesnakes and then releasing them again, so that they could sting without giving their characteristic alarm. Bad odors call for pure water, pure air, and careful, honest scrubbing. Nothing can take the place of these, whether disease is present or not. Let those who will, burn incense to their gods, but never, in the name of science, offer such a sacrifice to the god of stinks.

WHAT ARE ANTISEPTICS?

Septic changes in organic materials are due to the growth and multiplication of minute microscopic plants. Alcohol, glycerin, saltpetre, salt, sugar of lead, borax, camphor water, alum, and chlorate of potash, when used in quantities varying from two to twenty-five per cent. of their solution, check the development of such micro-organisms. The salts of zinc, boracic acid, Fowler's solution, iodide of potassium, salicylate of soda, and permanganate of potash, although a little more powerful, belong to the same class. As germ-destroying agents they rank so low that they are practically useless for disinfecting purposes.* Many of them possess no direct gemicide power. In their power of arresting putrefaction, common experience has demonstrated their value. They lessen the vital activity of moulds and bacteria, so as to check their genesis. By their use medicines and articles of food are preserved from fermentation. The salts of zinc seem to derive most of their efficiency because of their ability to precipitate the organic material of a solution, and so starve the bacteria.† All substances capable of arresting the development of these

---

* Nat. Board of Health Bulletin, vol. iii., p. 23.

† Science, vol. ii., p. 434.

minute organisms without being able to completely destroy them are classed as antiseptics. While antiseptics may be useful as deodorants, they are utterly unreliable as preventives of the spread of infectious diseases. The discovery of their great usefulness for dressing wounds and subduing inflammation is a triumph that modern surgery may well be proud of. Carbolic acid should probably stand at the head of the list, if we did not deem it worthy of a place among disinfectants. Its power as a germicide is small. In solutions of one-half of one per cent it fails to kill the micrococcus of septicæmia.* The crude article stands far lower than this. This agent has probably done more to cause the practice of disinfecting to degenerate into a farce than any other. But for its fearful smell forcing people to ventilate sick rooms, the results might have proved most tragical. When the stench becomes unbearable, they venture to let in pure air. Oxygen, although slow in its action, is known to modify the character of disease germs. The dilution of an infected atmosphere rapidly destroys its virulent qualities, and soon renders it innoxious.† The carbolic acid gets the credit for what the pure air did. The general public is deluded by the notion that a deodorant, antiseptic, or something of stronger odor than that of putrid matter is all we need to save us from disease. A piece of camphor, a sniff of cologne, or a fearful smell of coal tar serves them the same purpose with disease as a small bush does an ostrich when followed by a hunter. If it succeeds in hiding its head, it imagines itself safe. Many educated persons and even physicians entertain notions almost as crude. They know no distinction between disinfectants and antiseptics. A bottle of mixed chlorides will be commended by them in most laudatory terms, although a whole gallon of it could not kill a single anthrax spore. Lately a proprietary article of this kind has been extensively advertised, and a long list of facsimile autographs attached. The names are those of eminent men. Some of them have been dead long enough to show that their names were obtained before we had discovered a scientific means of testing such things. It is highly probable that many of them are to-day sorry that they lent

* Nat. Board of Health Bulletin, vol. iii., p. 23.

† Med. News, vol. xlvi., p. 318.

their names for such a purpose. The free use of antiseptics is commendable. The chlorides of zinc and copper are of great value in this way, but a better understanding of the subject than we have been heretofore in possession of will now enable us to do far more effectual work at a small raction of that we have paid for inferior articles.

WHAT ARE DISINFECTANTS ?

Superheated steam, high temperatures, some mercury, silver, and copper salts, mineral acids, and chlorine, bromine, and iodine are among the most powerful agents for destroying the infecting power of infectious material. They can destroy the spores of all microbes known to be the cause of disease. If we knew that every disease had its origin in a germ, as is now generally believed to be the case, then the words germicide, microbicide, and disinfectant would be synonymous. Men who have given the subject the most careful study, while refraining from using them as interchangeable, practically consider them so. Much of the present ambiguity of meaning might be gotten rid of if we would all look upon them in this light. Besides the few things mentioned above as infection destroyers, there are scores more known to science. These are among the best. As a rule, disinfectants make good antiseptics, since they can kill all septic germs, and completely check their multiplication. For such use they are usually very economical, owing to the high dilution in which they are efficient. Experience has shown that all good germicides are good disinfectants, all good disinfectants can be used as antiseptics successfully, and all good antiseptics usually make good deodorants. The reverse, however, is not true. Substances may be deodorants, and have neither antiseptic nor disinfecting power. They may be antiseptics, and possess no disinfecting power. Many of them differ only in degree of power. Such is true of such agents as weaken the germs in their vital resistance, because of their toxic qualities, when compared with all those above them in the list that act in the same manner. The vital resistance of micro-organisms is the test now used for the scientific determination of the value of every disinfectant. Until this test was agreed upon, we had no means of investigating

the subject with even an approach to accuracy. With it many difficulties lie in the way of precision.

Do the same disinfectants act on all germs alike?

If disinfectants react differently on different kinds of micro-organisms, it is clear that generalization must be difficult or impossible, according to the extent of such variable results. So far as now appears, the inference from what occurs with one kind when applied to another is only safe within certain limits. Within a class such as micrococci, conclusions can be drawn with more certainty then when we go out of it. What will kill the micrococci of pus is much more likely to destroy the micrococci of gonorrhœa than it would be to kill bacteria. When the kind is known that is hardest to kill, it will usually, but not always, be found that agents capable of accomplishing its destruction can rid us of all the rest. Sulphuric acid will destroy septic micrococci if only of the strength of one part in sixteen hundred, but it fails on bacteria, even of four times this strength. Caustic potash will destroy septic germs when of quarter the strength necessary to kill those of pus.* Oil of turpentine, although fatal to spores of bacilli in five days when diluted as much as one part in seventy-five thousand, has no effect upon the virus of symptomatic anthrax,† even of full strength. Bacillus subtilus will perish in a dilute alkaline solution, and flourish in one slightly acid. Bacillus anthracis can only live in one slightly alkaline, and perishes when a reaction becomes acid. Here we find two of the same genera reacting in the most opposite manner to the same agent. Bacteria germs will succumb to boric acid and septic micrococci to alcohol as no other germs will.‡ One of the best known general facts in this whole subject is that of the great difference between the resisting power of spore-bearing over non-spore-bearing germs. Tyndall has shown that in experiments performed by Dr. Roberts, spores of Bacillus subtilus have stood boiling for three hours before being killed, owing to their being old and dried.§ As a rule, a few seconds of a temperature above 140 degrees F. will destroy germs that bear no spores. The spores of anthrax

* Science, vol. ii., p. 434. † Bacteria, Sternberg's Magnin, p. 226.

‡ Bacteria, Sternberg's Magnin, pp. 215, 217.

§ Pop. Sci. Mon., vol. x., p. 648.

and consumption are hard to kill. As a rule, we can rely upon the destruction of all kinds of disease germs by conditions that will wipe out these. Asiatic cholera, diphtherea, small-pox, yellow fever, puerpural fever, and erysipelas are supposed to be caused by micro-organisms that bear no spores. Whether they are or not, our greatest safety lies in selecting for disinfectants such agents as will leave no doubt. We must use sporicides wherever and whenever we can. Of the many agents recommended for disinfecting purposes, quite a large proportion have not been tested by this high standard, or, having been so tested, they have failed. Weak disinfectants and powerful antiseptics may be successful in ridding us of disease in some instances, but the chances are that they will often fail. Half-done work, by encouraging a false sense of security, may be worse than no work at all. Lists of disinfecting agents have been drawn up by Koch, Klein, Sternberg, Magnin, Pasteur, Arloing, Cornevin, Thomas, Miguel, and many others. The last gentleman gives the following list of substances as possessing spore-destroying powers in the order named.* These were thoroughly tested, and quantity and time determined.

1. Biniodide of mercury.
2. Iodide of silver.
3. Corrosive sublimate.
4. Nitrate of silver.
5. Osmic acid.
6. Chromic acid.
7. Iodine.
8. Chlorine.
9. Prussic acid.
10. Bromine.

In this list the mercury and silver salts come first. One part in ten thousand of these, he says, will in a few days destroy spores as surely as a temperature of 302 degrees F. for several hours. To resist either for much less than the time given would require them to have unusual vitality. Koch shows that only ten or fifteen minutes are required for either.† In comparing the lists of various observers, discrepancies are observable. These will usually be found to be due to differences of time and conditions of exposure, which the authors or experimenters have failed to mention. Under identical conditions, results are the same.

* Med. Rec., vol. xxiv., p. 498.

† Med. News, vol. xlvi., p. 207. Mitthell aus d. K. Gesundheitsamte, Berlin, 1881.

How are disinfectants tested ?

The principle followed by all experimenters in determining the efficiency of disinfectants is the same, however they may differ in details of manipulation. The agent to be studied is brought in contact with the germs in definite proportions and for a definite time. If, after such germs are removed from the solution, and planted in a favorable medium under conditions favorable to their development, they fail to show signs of vitality, it is known that the disinfectant has done its work. If, however, they still live and multiply, it is a sure sign of a failure. Sternberg, the leading American authority upon such matters, uses cultivations of gonorrhœa, vaccinia, abscess germs, septic microbes, and the bacteria of putrefaction in most ordinary tests.* He also uses Anthrax tuberculosis and Bacillus subtilus spores when occasion requires. He makes standard solutions of his disinfecting agents required to be tested, in distilled water, and subjects a definite quantity of a cultivation of germs to a measured quantity of this for a given time. After two hours (or such time as he may see fit), he transfers some of these to a flask of sterilized beef tea. This is now put into an incubator at a temperature favorable to their growth (about 100 degrees F.) and kept there for 24 hours, or as much longer as may be deemed advisable. If they fail to develop, the disinfectant has killed them. If they develop but slowly, it has injured them. In this way he obtains positive results. When the septic organisms of broken-down beef tea are used, he claims that Bacillus subtilus is always present. This is one of the most stubborn tests, and a disinfectant that shows good results with it will usually prove reliable. It was in the manner here indicated that Dr. Duggan, under his superintendence, tested the various common commercial disinfectants. The samples were procured for him of druggists in New York and Brooklyn by Prof. Raymond. In a list of fifteen † only one was successful in two per cent. solutions, and it failed when diluted to one part in one hundred. Listerine, French phenol sodique, Burchardt's disinfectant, and Squibb's impure carbolic acid were so poor that they failed when added undiluted to an equal portion of the test solution of germs. The rest re-

* Science, vol. ii., p. 433.

† Med. News, vol. xlvi., p. 146.

quired from seven to thirty parts in one hundred to prove successful. The best one of the fifteen had the ill fortune to be too insoluble to be of much service, and cost more than any of the rest. A fair test of the money value of these and other such articles can only be had by a comparison of their germicide power and market rates with each other.

What is the relative cash value of disinfectants?

A disinfectant may sell in open market by the pound or pint at a low rate, and yet be much dearer for the same efficiency than one costing ten or even fifty times more. Picric acid at seventy-five cents per pound is ten times dearer than biniodide of mercury at five dollars and a quarter per pound. What we want is one commercially cheap and at the same time highly efficient. For the purpose of making such a selection, a table is here drawn up, based upon the experiments of Dr. Miguel.* The weights have been changed from metric to avoirdupois, the market price found, and the cost calculated for ten litres or quarts, having ten times the antiseptic strength of the original list. The cost of chlorine has been based upon the market price of good chloride of lime, containing twenty-five per cent. that is available. The order of every article has been altered for the purpose of establishing the uniform order of cash values. The number of grains of each required will tell their relative germicide power. When the amount is above 1,000 grains, their spore-destroying power is not very reliable. The ten good sporicides of the list have already been given in the relations of their efficiency, weight for weight. The rest, whether cheap or dear, rank much lower.

To make ten quarts of a standard solution of equal disinfecting power, we must use:

Full Cost.	Name.	Number of Grains.	Market Price.
0.00\frac{9}{10}$	Corrosive sublimate	100	$0.68 per pound.
.01$\frac{1}{15}$	Chlorine	375	.20 " "
.01$\frac{7}{20}$	Copper sulphate..........	1350	.08 " "
.02$\frac{1}{2}$	Mercury biniodide........	33$\frac{1}{3}$	.33 " ounce.
.03$\frac{1}{5}$	Mineral acids.............	4500	.05 " pound.
.08	Bromine	900	.60 " "

* Med. Rec., vol. xxiv., p. 498.

Full Cost.	Name.	Number of Grains.	Market Price.
$0.13½	Ammonia gas..............	2100	$0.45 per pound.
.14⅓	Chloroform	1200	.85 " "
.15	Chromic acid....	300	.22 " ounce.
.16½	Potassium chromate......	1950	.60 " pound.
.20	Silver iodide	50	1.70 " ounce.
.20⅗	Picric acid................	1950	.75 " pound.
.21⅗	Iodine	375	4.00 " "
.22½	Silver nitrate.............	125	.80 " ounce.
.30⅕	Potassium permanganate.	5300	.40 " pound.
.34⅕	Carbolic acid	4800	.50 " "
.56	Benzoic acid..............	1650	.15 " ounce.
.69	Salicylic acid	1500	.20 " "
4.62 9/10	Osmic acid..........	225	9.00 " "
4.80	Thymic acid..............	3000	.70 " "
11.00	Anhydrous prussic acid...	600	8.80 " "

If we now compare the cost of the same germicide power of proprietary disinfectants, the contrast is quite startling. The following list is based upon the experiments of Sternberg, already cited. The four that failed at fifty per cent. we can for convenience assume to be potent at seventy-five. One hundred grains of corrosive sublimate, costing at pound rates only nine-tenths of a cent, is our standard of comparison. This is dissolved in ten quarts of water. The prices are those of jobbing houses.

Full Cost.	Name.	Equivalents.	Market Price.
$0.00 9/10	Corrosive sublimate	100 grs.	68 cts. per lb.
13.00	Little's sol. phenyl............	20 qts.	65 " " qt.
35.00	50% chlor. zinc, Squibb's......	100 "	35 " " "
35.00	Feuchtwanger's disinfectant..	100 "	35 " " "
51.00	Phenol sodique (H. Bros. & W.)	150 "	34 " " "
66.00	Platt's chlorides..............	200 "	33 " " "
80.00	Girondin	250 "	32 " " "
80.00	Williamson's sanitary fluid...	250 "	32 " " "
80.00	Bromo-chloralum.............	250 "	32 " " "
96.00	Blackman disinfectant........	300 "	32 " " "
112.50	Squibb's sol. impure car. acid.	750 "	15 " " "
182.50	Burchardt's disinfectant......	750 "	23 " " "
255.00	Phenol sodique, French......	750 "	34 " " "
495.00	Listerine......................	750 "	66 " " "

Many of these are put up and sold in bulk. If so bought, it would be necessary to reduce the figures a little. Most consumers are compelled to buy by the bottle, and the calculation is therefore based upon quarts. The retail price is from thirty to forty per cent. higher than here given. These comprise the pick commercial disinfectants in the market. Most of them are prepared by educated chemists, who are supposed to know something about the subject. In fact, they represent the very best knowledge of a few years ago. When the best are so poor, what can we hope for from the hundreds of inferior ones, palmed off upon a helpless public by ignorant charlatans who neither know nor care what the value of their goods may be, provided they can be sold? Mr. Wynter Blythe, when speaking of the long array of worthless disinfectants at the London Health Exhibition, has well said: "Quackery takes a well known common powder, labels it with a grand mystic name, selling bright copper at the price of gold." *

CAN WE DISINFECT AERIALLY?

Disinfection by means of the air is probably more implicitly relied upon by most people than is any other method. Under scientific tests it has given the least satisfaction. For this method, gases and volatile bodies are used. None of them are of the least value, unless used in such quantities as will render the air utterly unfit for respiration. It is but a waste of money and labor to use less than enough to kill everything having life that dares to remain in the room while disinfection is going on. Even then, if the air is dry, the work will be imperfectly done. It can only be accomplished properly by saturating the atmosphere both with moisture and the disinfectant. Fischer, Proskauer,† Baxter,‡ Sternberg,§ and others have lately worked this field of investigation faithfully. Many kinds of pathogenic and non-pathogenic micro-organisms have been used as tests. Sternberg's experiments with vaccine lymph are interesting in this connection. He sub-

* Med. News, vol. xlvi., p. 144.

† Ibid., p. 82.

‡ Report of Med. Off. Priv. Counc., 1875.

§ Nat. Board of Health Bulletin, vol. iii., p. 21.

jected it to the action of the agent under examination, dissolved in glycerin and dried upon ivory points and cardboard. The same child was vaccinated at one sitting, twice on one arm with exposed lymph and twice on the other with unexposed. By using both kinds, such children as were not susceptible could be eliminated. With them, neither kind took. Such lymph as had become sterile by a long enough exposure, or had been attacked by a strong enough agent, of course failed, even in children where the other arm was affected. Chlorine, sulphurous acid, and nitrous acid, in the proportions of one volume of gas to ninty-nine volumes of air, were efficient for germs bearing no spores, when the air and objects were moist and the exposure lasted over one hour. Bromine is nearly five times more efficient in the same proportion. Chlorine, nitrous acid, and bromine require experience and great care in their management. In the hands of people not acquainted with their properties, their use is risky to the life and health of the handler, as well as destructive of valuable articles of use and ornament.

IS OUR METHOD OF USING CARBOLIC ACID A FARCE?

Carbolic acid, upon which so many rely, came out of the trial in very bad shape. For a room having a capacity of twelve cubic feet, it was proved that *seventeen pounds of the very best crystals* would be required. This too must be completely vaporized in six hours, while suspended in different parts of the room, and every door and window closely closed. The crude acid, to whose abominable odor so many submit with patient resignation under the delusion that they are martyrs to the goddess Hygeia, is far less active than this. Of it *more than sixty-eight pounds* must meet with the same treatment in the same time, or we cannot hope for the smallest approach to safety.* As an antiseptic, this agent has long and worthily held a high place. As a disinfectant, it must be discarded for superior agents. As now used it is a delusion and a snare. Heat, steam, and sulphurous acid must perform not only its task, but that of the powerful agents chlorine, bromine, and

* Nat. Board of Health Bulletin, vol. iii., p. 21.

nitrous acid. Dry heat, at a height that is operative chars and damages many fabrics. Superheated steam, where available, is the best of the lot. It will destroy germs in baled rags, when everything else has failed.* Sternberg's late experiments in Brooklyn showed it to be far superior to compressed sulphurous acid.

IS SULPHUR FUMIGATION USEFUL ?

No plan of disinfecting has been longer practised or more implicitly relied upon than this. The antiquity of its use and the high esteem in which it was held by the ancients are attested by the following quotation from Pope's Homer's Odyssey, book xxii.:

> "Bring sulphur straight, and fire (the monarch cries).
> She hears, and at the word obedient flies.
> With fire and sulphur, cure of noxious fumes,
> He purged the walls and blood polluted rooms."

In spite of Ulysses' faith in this agent, and contrary to the accepted opinions of millions of this and past ages, the fumes of sulphurous acid *are not reliable*. Modern investigation has shattered this ancient idol. Wolffhügel, after a careful study of this own and Koch's experiments with it, deliberately concludes that it must be abandoned.† It is a good antiseptic, and in a moist atmosphere will destroy the infection of non-spore-bearing diseases. Further than this it cannot be commended. Its action even here is but superficial. To hope by its use to be able to destroy such organisms as multiply by fission, when they are covered by clothes or buried amid bundles of rags is a delusion. To expect successful fumigation where there are free currents of air, or but small quantities used, is equally fallacious. Reliance must never be put upon it alone. When it merely supplements some other more powerful agent, it is all right. Its use in ships and at quarantine stations upon the persons of travellers is only worthy of derision. To get the least benefit from it in a well closed room and moist at-

---

* Med. News, vol. xlvi., p. 346.

† Viertelj. f. Oeff. Gesund., 1880, t. xii., pp. 1882–33, and Medical News, vol. xlvi., p. 349.

mosphere, not less than three pounds of sulphur must be burnt for every thousand cubic feet.

HOW SHALL WE RID THE AIR OF SPORES ?

It is unfortunate for us that these "seeds" of the microbes are so hard to kill, for they are the very ones most likely to be found in the air, because of their lightness. When dried, they are the most minute and light of all known living matter; and the drier they are, the more likely they are to float and the harder to kill. Tyndall procured an optically pure atmosphere by carefully closing the space and leaving the dust to quietly settle. Deserted rooms, where neither motion nor draft occurs, allow their dust to settle. With dust, disease infection sinks if that infection is due to germs. Once down, a powerful disinfecting solution, wetting the whole place, followed by a good washing of floor, walls, ceiling, and furniture with the same, will rid the place of disease if anything short of fire can. Here as elsewhere there is no excellence without labor. Free ventilation, by dilution and dissemination of the spores, contributes its share to our relief. How it does so is not well understood. Probably the oxygen of the air may slowly modify them, as has been pointed out by Pasteur and Buchner. It is more likely due to the little understood principle of the relativity of infection. To the diffusion of disease germs we are perhaps indebted for the numerous little nameless ills with which every physician is familiar. Attacks of all contagious diseases seem to be relative, varying in degree of severity according to the quantity of virus imbibed, as well as according to constitutional predisposition. What would, with a heavy sowing, be a most deadly malady, may, by a very light one, only produce slight malaise, headache, or nausea. Between such extremes the disease may exist in numberless degrees of severity. The facts upon which this surmise is based are rapidly pressing themselves home upon observing physicians the world over, and have been demonstrated for some diseases in animals already.* If this is true, it necessarily follows that every disinfectant that is certain as a sporicide, by merely reducing the number does a good work,

* U. S. Agricultural Report, 1881-82, p. 289.

whether all are killed or not. Partial disinfection, if done with a good agent, is far better than none at all. It is not practical to thoroughly disinfect occupied apartments, but even the sprinkling or spraying of powerful germicides is of advantage, the decision of the Committee on Disinfectants of the National Board of Health to the contrary notwithstanding.* Free ventilation both before and after disinfection will insure better results.

HOW SHALL WE USE DISINFECTANTS ?

At the outset of the disease all superabundant furniture, ornaments, clothes, carpets, etc., should be removed from the room, cleaned, and disinfected. Carpets, clothes, and all heavy textile fabrics left in the room during the disease should be subjected to the action of superheated stream or fumigation for several hours, and then well beaten in the open air. If boiling will not injure them, they should have at least half an hour of such treatment, being sure that the water reaches every part. Then sprinkle or soak with some, to them, harmless disinfectant. Clothing in contact with the patient should be of little value, and burnt after use. All sputa, vomiting, and excreta should be treated with the most powerful agents —fire where practicable. Every patient sick with a contagious disease should be quarantined. All means of egress or ingress should be hung with sheets kept constantly wet with a good odorless disinfectant. Open windows should be curtained with mosquito netting kept moist with the same. Where practicable, every such patient should have his bed canopied with two folds of such netting, one permanently attached to supports, the other removable at will. The outside one could be removed, soaked in the disinfectant, gently wrung out, and replaced again. Its fibres, cold from evaporation, would attract all warm dust into its meshes and destroy all floating germs. Through it the patient could be seen, and overlapping folds by the bedside would allow the nurse to provide everything required for comfort or well being. Its cost would be small and its benefits large. It would cool the air breathed by the patient, and save all annoyance from flies or mosquitoes

---

* Medical News, vol. xlvi., p. 426.

All who die of such diseases should be well washed with the best disinfecting solutions, and this advice if followed for the living cases would do no harm, and very likely some good.

WHAT ARE THE BEST DISINFECTANTS ?

The two articles that head the list of germicides already given are without doubt the best now known, all things considered. They are not perfect by any means. Mercuric chloride, properly known as corrosive sublimate, has received the seal of sanction of the American Public Health Association. All authorities unite in commending it except one, and he apparently because he loves to oppose Koch.* Sternberg points out how he blundered.† There are a number of serious drawbacks to its use. Some can be overcome, others cannot. Its ability to coagulate albumen makes it almost useless as a destroyer of infected sputum or for use with compact fæces. Its corrosive action upon metals forbids its use in large quantities where it must be carried off by metal pipes. It cannot be kept for use in tin or brass pails. It is precipitated as sulphide by sewer gas and rendered almost useless. Its solutions, being odorless and colorless, might cause it to be swallowed in mistake for water. Light and heat as well as other conditions tend to precipitate it in neutral solutions as inert calomel. It is intensely poisonous. Its past medical uses have produced a senseless prejudice in the public mind against it. This public prejudice it must outgrow. *In solutions of equal antiseptic power* it is little, if any, more poisonous than saltpetre, borax, or tartaric acid. One-thirteenth of a grain in half a pint of water can be swallowed with impunity. We would not fare as well if we took in an ounce of borax dissolved in the same amount of water, yet the two are antiseptically equal. Its precipitation as calomel is checked by the presence, in the same solution, of salt, muriatic acid, or muriate of ammonium. Fatal blunders in mistaking it for water can be avoided by a large red label bearing the word "poison," or by following the advice of the Committee on Disinfectants of the

* Micro-organisms and Disease, Klein, p. 188.
† Medical News, vol. xlvi., p. 206.

American Public Health Association and introducing a small quantity of permanganate of potash to color it. A larger quantity, acting as an oxidizer, will help it to overcome its power of coagulating albuminous matter. For privies and sewers chlorine must be used, probably as a hypochlorite. It must be kept away from metals. For disinfecting clothing that cannot be immediately submitted to boiling water, for cleansing furniture, washing walls, floors, ceilings, and all woodwork of a house, for spraying or flooding otherwise inaccessible spots, for sponging patients and for washing the dead, no other known agent can take its place. The sensitive olfactories of patients are annoyed by no vile odor during its use. Kept in wooden, glass, or earthen vessels, it can remain by the sick bed ready for immediate use. Houses properly disinfected by it will for some time be free from bugs, roaches, ants, and fleas as well as disease Proper washing with pure water after it will remove all danger from i s presence. Strong solutions can be kept till required, and then properly diluted with water. They should always have a bold, plain poison label upon the bottle. The following solution is a good one :

R. Corrosive sublimate.......................... ℥ j.
Table salt.................................. ℥ v.
Water (warm)................................ Oj.

This solution will cost a druggist less than five cents. Half an ounce of it in a gallon of water will make a disinfectant capable of killing spores in less than an hour, and not one commercial disinfectant in the market can do so. From two to four ounces of it will when added to a gallon of water do for disinfecting discharges. For this purpose two drachms of permanganate of potash should be added. For sewers, privies, and most outdoor use the hypochlorite of lime. or, as popularly known, chloride of lime, takes the lead. Its great defects are strong odor and unreliability of quality. It should contain at least twenty-five per cent. of available chlorine. All wet specimens should be rejected. It has changed into chloride of calcium. All specimens leaving a very dense deposit in solution with water should be refused. It has not enough chlorine. Good chloride of lime is quite dry and nearly all soluble.

One pound should dissolve in four gallons of water with very little sediment. A pint of such a solution makes the best known disinfectant for the discharges of patients with contagious diseases, and for infected sputum enough to fill a teacup will answer. Privy vaults can be given a pound or two of powdered bluestone (sulphate of copper), sulphuric acid, or chloride of lime, according to the whim of the owner. They are all cheap and efficient. The last two, however, are the best, and the chloride of lime beats all.

CAN DISINFECTION SAVE US FROM THE PENALTY OF FILTHINESS ?

We laugh at the absurdity of a past generation because of its reliance upon the charm of a cross drawn with tar upon the barn door in cases of cattle plague.* We feel shocked at their absurd petitions to heaven for protection from plagues brought on by their own filthiness. We are scarcely as dirty as they were, nor do we suffer from pestilence as they did. We are still guilty as a race of putting prayers where work belongs, and slavishly relying upon some useless measure to charm off the demon of disease. The majority of men have yet to learn that disinfection without work is dead. Cleanliness, vigilance, temperance, and constant ventilation must be its constant associates. If people are too lazy to clean themselves and their surroundings, and too vicious to observe self-denial and temperance, they need hope for no scapegoat to bear their load of sin. With disease-harboring dirt environing them, and constitutional weakness from dissipation, they and their homes are the hotbeds where plagues propagate and bring suffering upon the innocent people around them. Such people only make a fetish of the best disinfectant science can give them. They are too lazy to use it properly. The work of cleaning, ventilating, and disinfecting must go hand in hand, and be done with the utmost thoroughness. Dirt breeds disease. Cleanliness destroys it. Disinfectants are only aids to cleanliness. The small mortality of our age during the advent of a plague is solely due to our advance in ability of keeping clean As we become more painstaking, so will we be less

* North British Review, vol. xliv., p. 477.

scourged. Is it any wonder they used to suffer so from contagious diseases ? Here is a picture of what the British peasant once was : "In times gone by, and even later than Shakespeare's, our floors were the earth only, as in many cottages now, and we used the broom or brush little, and threw the garbage down, allowing it to lie and rot and become so vile that we invented the device of covering it over with straw so that it might be trodden down, as the cattle make the manure in the straw yards. The earth of the floor was overweighed with putrid matter, and much of it came into the air of the room, but the formation of nitre or saltpetre began, and oxygen accumulated rapidly, and rendered even these houses habitable in a way."*

* North British Review, vol. xliv., p. 465.

DISINFECTANTS AND THEIR USE.

No. 21.

DISINFECTANTS should be cheap, yet reliable, and also act as antiseptics, be easily manipulated by any one, material be easily obtained, and practical in their sanitary effects.

Below I give a disinfectant for malarial diseases, small-pox, diphtheria, scarlet fever, malignant cancerous sores, etc. Its strength can be increased or decreased, as desired, by regulating the amount of water. For fumigating rooms, stables, cellars, sewers, ships, privies, etc., etc., it is easily employed, and very thorough, as the gas penetrates every crevice, even to the destruction of vermin:

℞. Chloride lime,
Sulphate zinc.............................. aa ʒ ij
Carbolic acid,
Oil eucalyptos..............................aa ʒ j
Alcohol.... .... ℥ ij

Place the lime and zinc in a half-gallon bottle. Mix the acid and oil and alcohol; shake and turn in bottle with one quart of water, cork, and shake occasionally, for the water to absorb the gas. Settle, decant, and bottle.

For use.—To every ℥ of this strong liquor add 1 qt. of water, or more, as required. This can be placed in dishes in a room, or turned into vessels to disinfect the same, or to soak clothing in. To fumigate a room, leave all furniture and carpets and bedding and clothing where they are, and use the following:

℞. Chloride lime............................ ¼ lb.
Sulphate zinc.............................. 2 ℥
Carbolic acid.............................. 1 ℥
Oil eucalyptos.............................. 1½ ℥
Water.............................. 1 qt.

Put the lime and zinc in open dish; mix the acid, oil, and water; place dish in place where wanted; then turn on the mixture and close the room; the gas will form, and seek every crevice and thread of cloth.

When well fumigated, open and expose to the air, to remove excess of smell if it is too disagreeable.

MULTUM IN PARVO, No. 2.

CHOLERA AND DIARRHŒA, AND THEIR PREVENTION.

THE appearance of cholera in the towns of western Europe during the past season, and the probability that it will reach America during the present summer, make it desirable that some plain facts about the disease, and the way in which it spreads, should be generally known and understood.

The spread of cholera is due to filth, and to drinking water or milk not absolutely pure and free from all pollution. Cleanliness of every kind is, therefore, the great safeguard against the coming of the disease, and against catching it if it does come. The only way known of fighting against it with success is to destroy its breeding places; hence, all accumulations of filth, in the house, in the yard, gutters, drains, sewers, streets, *must be prohibited.* The necessary refuse of the house must be kept undecomposed, until removed, by disinfectants and antiseptics. All refuse must be removed just as soon as possible, and the causes of all foul smells must be *at once removed.*

PRECAUTIONS.

1. The earliest symptom of cholera is looseness of the bowels; and when cholera is about, every person attacked with the slightest looseness of the bowels should *at once* secure proper medical attendance. Children suffering from diarrhœa should be taken directly to a competent medical man. The premonitory diarrhœa is at first generally painless and watery, but soon increases in frequency and copiousness, the discharge being colorless, or like "rice water," and ejected with force. Vomiting is also generally present. Purgative medicines should not be given unless ordered by a legally qualified and trusted practitioner. *Do not neglect these beginnings of disease.*

2. All sudden checks to perspiration should be avoided,

and a flannel shirt or belt should be worn at all times to avoid such a result. *Wear flannel constantly.* Great attention should be paid to personal cleanliness. The whole body should be sponged or washed daily with cold or tepid water and soap. The underclothing should be kept thoroughly clean.

3. Every person should live temporately and regularly on those articles of food which they are used to, and which agree with them. Fish, fruit, and vegetables may be taken with impunity, provided they are ripe, sound, and free from all taint. *All food that is unsound, stale, or tainted, and smells disagreeably, must be avoided.* Great care should be taken not to give stale, sour, or tainted food to children. *Sour and tainted milk is one great source of diarrhœa in children, and should on no account be given to them.* The concentrated milk is a good substitute for common milk when it cannot be got fresh and pure. *Never give "corrected" milk to children.* Keep constant and unremittent watch over the bottle from which the nursing child is fed.

4. Intemperance and drunkenness induce attacks of cholera and fatal diarrhœa. Temperance in eating and drinking is a great safeguard against all fatal diseases of the bowels. *The intemperate are the first and often the only ones attacked in a community.*

5. It is of the utmost consequence to avoid all foul smells, as of sinks, closets, drains, dust-bins, sodden earth, and the like. It should be remembered that every closet and sink which lets water down to a drain may allow bad air to come back, so that the *traps* should be looked to regularly, and be kept well charged with water and some disinfectant, such as a solution of green vitriol (copperas); five pounds to a pailful of water should be put down daily

6. One of the great sources of health is *fresh air.* The poison of *all* infectious diseases may be diluted and destroyed by it. Hence the importance of having every room sweet by keeping open the doors and windows, so long as the room is not made cold thereby. *More than half the deaths arising from contagious diseases in this country are produced by the pernicious habit of excluding the access of fresh air.*

7. As drinking water is known to be the great source of communicating infectious diarrhœa and cholera, the greatest care should be taken to secure pure water for drinking purposes. None should be used that is not quite bright; and this, during epidemics, should be boiled, and flavored with tea, coffee or burnt bread If at all turbid or discolored, it should be allowed to settle, and should be *boiled and filtered before drinking.* No water should be drunk which comes out of a dirty butt, or that has been standing near a sink or closet, or in a sick room. All cisterns should be thoroughly cleansed, and wooden butts be charred or pitched inside. *The water from the street pumps should be avoided. Milk should be boiled.*

8. Where regard to epidemic cholera, it should be recollected that all the discharges from the body, the mouth as well as the bowels, are highly contagious, and persons who attend upon the sick should wash their hands and face before taking any food, and should not be allowed to take any food in the room occupied by the patient. *Personal cleanliness must be insisted upon.*

9. Get daily an abundance of *pure fresh air, pure water, pure food*, and *pure sunlight*, try to avoid overwork and worry, and live in a pure, clean, and happy home, and you will in all probability avoid these diseases.

TREATMENT.

When persons are attacked by severe diarrhœa and cholera, if possible, it is better that they should be sent to a hospital than be badly treated at home. Infected clothes, and bedding, and apartments should purified under the direction of the medical attendant or sanitary inspector. All that passes from the sick should be looked on as highly poisonous. and got rid of at once by burying in the earth; and every vessel, and sink, and cloth, or article of bedding or clothing that he touches ought to be disinfected thoroughly by a trained person. A strong solution of sulphate of iron should be kept in the vessel which receives the discharges from the person. The patient should be kept in perfect quiet, with no running in and out of the room, and *should be kept lying on his back in bed.*

In case medical aid cannot soon be secured, keep the patient quiet on his back, a mustard plaster placed

over the abdomen, the feet placed in hot water, or in a hot mustard foot-bath, and internally the following mixture

℞. Chloroform,
Laudanum,
Spirits of camphor,
Essence of peppermint,
Aromatic spirits of ammonia, of each f ʒ jss.

Dissolve a teaspoonful in a wine-glass of ice water, and of this give two teaspoonfuls *every five minutes*. Keep the patient on his back, and call a physician as soon as possible.

AVOID A PANIC.

If cholera should unhappily reach our land, and become prevalent in our midst, it is important for every one to remember that he is responsible for doing his share in warding off the common enemy. Panic and fear are the worst weapons in warding off cholera; cleanliness and courage, the best weapons. For house visitation discreet and careful persons should be chosen, persons who will not be likely to excite fear or a panic among the people. Finally, let it be remembered that the local conditions which enable cholera to spread, if it is introduced, are the very conditions which, day by day, create and spread other diseases, such as *typhoid fever*, diphtheria, diarrhœa, and the like, diseases always present in the country, and which, in the long run, are far more destructive to human life than cholera.

G. G. GROFF.

Lewisburg, Pa.

DISINFECTANTS

AND

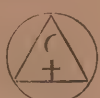
THEIR USE.

W. O. ALLISON, Publisher.

NEW YORK:
DRUGGISTS CIRCULAR PRESS.

1885.

CONTENTS.

No.	Nom de Plume.	Real Name and Address.	Page
1.	T. H. S.	T. H. Salmon, M.D., 677 John St., Lansingburg, N. Y.	1
2.	Agricola.	G. G. Davis, Frewsburg, N. Y.	10
3.	R. H. B.	Robert H. Bernhardt, San Antonio, Texas.	16
4.	Paracelsus.	George G. Groff, M D., Lewisburg, Pa.	25
5.	L. J. S.	Le Roy J. Simpson, M.D., Montgomery, Ala.	30
6.	Charcoal.	Marcus Benjamin, 43 E. 67th St., New York City.	37
7.	E. Sum.	J. M. Worthington, M.D., Annapolis, Md.	57
8.		Albert Collins, Ph.G., Chicago, Ill.	66
9.	Multum in Parvo. No. 1.	Ferdinand Lascar, New Orleans, La.	70
10.	O. K. L. L.	L. Lesaulnier, Red Bud, Ill.	75
11.	Nulla Dies sine Linea.	B. W. Palmer, A.M., M.D., Detroit, Mich.	77
12.	SO_2.	B. W. Dows, Phœnixville, Pa.	87
13.	Common Sense.	R. S. Keelor, M.D., Phœnixville, Pa.	90
14.	Brevitas.	No name received.	96
15.	G. M. B.	Geo. M. Beringer, Philadelphia, Pa.	99
16.	Periissem M. Periissem.	Robert Layton, Jr., Monroe, La.	114
17.	Biniodide.	August Schachner, Louisville, Ky.	119
18.	Sub sole, nil perfectum est.	Theo. A. Hoffmann, Sr., Beardstown, Ill.	128
19.	Trichloroacetic Acid.	F. L. Harding, 255 Sixth Ave., New York City.	135
20.		R. G. Eccles, M.D., 94 Smith St., Brooklyn, N. Y.	144
21.	Multum in Parvo. No. 2.	S. H. Dimick, Ypsilanti, Mich.	164

Cholera, its Detection and Treatment. Dr. G. G. Groff. - 165